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FOREWORD

The following extract from *Nature* of 6th March, 1943, which only lately reached East Africa, holds such great and immediate promise for these countries that it deserves the widest publicity:—

"Because, in contrast with animal protein, plant protein is poor in some of the B vitamins although rich in others, it is important to supply the missing types to human and animal diets when plant protein is consumed. Recently it has been found that micro-organisms build up all the members of the vitamin B group and that their protein is of the same high nutritive value as animal protein. These facts have been the basis of recent work at the Chemical Research Laboratory, Department of Scientific and Industrial Research, which has led to the production of 'Food Yeast'. For the factory in Jamaica, an organism has been developed at the Laboratory from a yeast used during the war of 1914-18 for feeding purposes, though at the time nothing was known about its vitamin content. The organism developed is double the size of that originally tried. This facilitates large-scale manufacture and the product is somewhat richer in some of the B vitamins than the original type. When dry it contains as much as 50 per cent of high-grade protein, approaching in nutritive value to meat and fish protein. Its vitamin B content is definitely higher than that of animal protein, including liver.

The product known as 'Food Yeast', which has resulted from the researches of the Chemical Research Laboratory, has a slightly meaty taste and is of light straw colour. It can be mixed with water or milk or added to soups and stews, to which it imparts a pleasant meaty taste. It could be successfully incorporated into biscuits and could, if added to flour, yield a most palatable loaf; 5 per cent of it, added to a 2 lb. loaf, would increase its nutritive value as much as would the addition of a ¼ lb. of beefsteak or two eggs. Food Yeast can be produced from waste molasses when nitrogen in the form of ammonia or ammonium salts is added, and its production is extremely rapid. A continuous process has been developed: a solution of molasses and the necessary ammonia and phosphate enter one end of a vat, and an equivalent volume of yeast in suspension is withdrawn from the other. Thus a product containing a high concentration of B vitamins and a high-grade protein is made in a matter of hours. This may be significant during the immediate post-war period when the depleted animal stock of Europe will be insufficient to provide meat and milk for the underfed populations of the occupied countries. In the tropical and sub-tropical countries it may also find an important application, for native diets are often deficient in vitamin B. It is estimated that Food Yeast can be supplied at 6d. per lb., and ½ oz. taken daily would ensure to the native a sufficiency of B vitamins."

From any less authoritative source "Food Yeast" would sound too good to be true. At the present juncture it offers means of palliating meat shortage: in the long run it would be a supplement of the greatest importance to the health of all races.

To the development and well-being of East Africa, through the increased efforts of a more healthy population, it is possible that "Food Yeast" might contribute scarcely less than tsetse control, the subject of an important article in this number. In this article Mr. Bax reviews the tsetse problem and shows how, even with our present imperfect knowledge, much can be done to reclaim land from fly. His views should be read in conjunction with those expressed in the articles by Hornby, Lewis and Staples published in recent numbers of this *Journal*. Although much valuable knowledge has been acquired in recent years it is obvious that a great deal more research is necessary before we can hope to gain the knowledge needed to give us real control over the tsetse. The final solution will probably be found, not through entomological research alone, but through the combined efforts of medical, veterinary, entomological and other research workers. No panacea can be hoped for, although, according to one authority, it is not impossible that a method for premunizing animals against trypanosome infections may be developed or a therapeutic agent discovered which would also give prophylaxis.

Dr. Fairbairn's article deals with a closely cognate subject: how people who for their own salvation have been concentrated in a sleeping sickness settlement can maintain themselves. The agricultural problem is a very real one because the soils of the areas concerned are often excessively poor.

Of the other contributions in this number special attention may be drawn to Mr. Graham's thoughtful plea for the most careful attention to the place of forestry, and the forest areas, in the economy of Kenya as a whole.

CORRIGENDUM

In Vol. VIII, No. 4 (April, 1943) p. 231, para. 2, line 10, *for* 6,000 lb. *read* 60,000 lb.

A PRACTICAL POLICY FOR TSETSE RECLAMATION AND FIELD EXPERIMENT

PART I

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Introduction

A search for cheap and practicable means of reclaiming* land from the tsetse-fly has continued for nearly twenty years in East Africa. Progress at first was slow, as a small body of field and laboratory worker, hampered by shortage of funds and staff, gradually reduced to order the complex subject of various species of tsetse living under widely differing environmental conditions. From the very beginning practical reclamation formed a part of the programme, but in spite of increasing ability to reclaim, which has led to the freeing of about 1,000 square miles in Tanganyika Territory,† thousands of square miles on balance have been lost to the Territory during those years.

In this paper are described the tsetse situations which long acquaintance and experience, field experiment and practical reclamation show can be remedied with to-day's knowledge. The time has come when East Africa should make use of this knowledge—should begin to draw dividends on the money spent on tsetse research—by formulating and carrying out a definite aggressive tsetse policy. The time is past when it was reasonable to regard the tsetse as a pest to whose handicapping presence the country must submit indefinitely.

A new prospect is opening before the tsetse worker to-day. As he stands on some eminence and surveys the tsetse-infested bush in which no domestic animal can live, stretching before him to the limits of the horizon, his feeling is not one of dismay at the magnitude of the problem, but rather one of elation at the consciousness that he is gaining power to deal with such immense areas. His trained eyes have discarded great blocks of vegetation, ten, twenty or more square miles in extent, which, though they harbour tsetses in numbers sufficient to kill any domestic stock entering them, yet in fact are of no account. Rather have his eyes fastened on narrow bands of small blocks of vegetation forming but a fraction of the whole; these foci are the key to the whole wide expanse of bush; if this conception is correct, destroy them, and all the tsetse infesting the intervening woodland will die out bereft of their bases.

In the old days expensive hand-made barrier clearings played a vital part in reclamation. Clearings were necessary to bite off blocks of bush of a manageable size from the great mass of the fly-bush. To-day their importance is declining. If great areas of certain kinds of vegetation can be disregarded as of no value to the tsetse, then the cost of reclamation per acre comes down enormously and blocks of a size which hitherto it would have been quite impossible to tackle now become perfectly manageable; the tsetse worker begins to find that he can work to natural instead of expensive and unsatisfactory artificial boundaries. This in turn means that agriculture and stock-rearing need no longer be subject to the suffocating restrictive influence of the tsetse-fly, but that they can freely develop on the lines best suited to them; they need not conform to a tsetse pattern, but can develop to a pattern carefully planned for the greatest well-being of the country. The goal to be arrived at—the ability to reclaim cheaply any kind of country from any species of tsetse—has not yet been attained; it is still necessary to compromise with the tsetse in large measure; but a great advance has been made in the last ten years and the whole conception and emphasis of tsetse reclamation is changing.

Tanganyika naturally bulks large in the following pages, but the author has endeavoured to keep his eyes on the wider East African horizon. Colonial Development Fund money was voted to the Tsetse Research Department for large-scale experiments in the belief that the results would be of value to the whole of East Africa, not to Tanganyika alone.

* Throughout this paper, for convenience, the term "reclamation" is used in its narrower sense, namely to designate measures undertaken to free land from tsetse-flies, or to safeguard land in immediate danger of invasion by them. The importance of the wider aspect, which includes provision of water, anti-erosion measures, controlled grazing and so forth, is of course fully appreciated.

† Approximately 169 square miles have been reclaimed in the Shinyanga sultanate alone. This sultanate's population is said to have been reduced by tsetse invasion to little more than 3,000 in the early nineteen twenties; cattle had become very few. Reclamation has revolutionized the position. To-day there are 12,000 people and a cattle population of 29,000 and 29,000 small stock.

THE NATURE OF THE PROBLEM

The Tsetse.—The layman in East Africa is beginning to realize the magnitude of the tsetse-fly problem. In Tanganyika the enormous proportion of two-thirds to three-quarters of the country are under tsetse, probably about one-seventh of Kenya [1] is affected, and one-fifth of Uganda. (Figure supplied by Uganda Medical Department.) Vast areas of other parts of Africa are dominated by the tsetse. (It is estimated that some four and a half million square miles of the African continent are under tsetse.) Even so the problem would be a comparatively simple one were but one species of tsetse concerned, but there are four main East African species, *Glossina morsitans, swynnertoni, pallidipes* and *palpalis*, and six subsidiary ones (*G. longipennis, brevipalpis, fuscipleuris, nigrofusca, fusca* and *austeni*). Each of these species has its own vegetational preferences and special habits and constitutes a problem in itself. Then again the practical difficulty and expense of dealing with a position is often complicated by the fact that two or more species are found together. Often there is a state of flux. Advances take place into areas as yet uninfested or a second species is found to be invading country already occupied by one or more. Finally cycles of wet and dry seasons appear to lead to temporary advances or retreats, depending on whether the tsetse is occupying country towards the wet or dry limits of its range.

It is not intended to give more than a very brief description of the type of vegetation the main species inhabit and the trypanosomes carried by them. The subject has been very fully dealt with elsewhere. [2]

G. morsitans.—This is one of the most important species in Africa with a very wide distribution. In Tanganyika it occupies chiefly *miombo* (*Isoberlinia-Brachystegia*) wooding and is probably in possession of half of the entire area of the territory. It also occurs widely in Uganda, but has not been authentically reported from Kenya. [1]. *G. morsitans* is a vector of the trypanosomes of domestic stock, and wherever it occurs in numbers the keeping of live stock is impossible. It is a vector too of *Trypanosoma rhodesiense*, Rhodesian sleeping sickness, the more severe type of sleeping sickness in man. A very large area of Tanganyika is infected with sleeping sickness, which is extending its range, and *morsitans* is the chief tsetse-fly implicated.

G. pallidipes.—This tsetse is also widely distributed, assuming very great importance in Kenya and Tanganyika. It is catholic in its vegetational requirements, being found in Tanganyika, both in the *miombo* and thorn-bush country, and therefore often associated with *G. morsitans* and *sywnnertoni;* but where-ever it occurs thickets are an essential requirement. It is a very important carrier of trypanosomiasis in stock, and the fact that it does not come readily to man makes its presence difficult to discover, even though stock losses may be serious. It has not yet been convicted of responsibility for an outbreak of sleeping sickness.

G. swynnertoni.—This species has a restricted distribution when compared with the former two, though it infests many thousands of square miles of Tanganyika and extends into Kenya. It is not found in Uganda. *G. swynnertoni* is an inhabitant of the dry thorn-bush (*Acacia-Commiphora-Ostryoderris*—other genera). It also is a vector of *T. rhodesiense*, the severer form of sleeping sickness in man, which infects extensive tracts in Northern Tanganyika, and it is also, wherever it occurs, a carrier of trypanosomes of domestic stock.

G. palpalis.—This is the lake-shore tsetse and has a wide distribution, occurring in East Africa around the Great Lakes and on the rivers flowing into them. It is the vector of *T. gambiense*, the trypanosome responsible for the milder form of sleeping sickness in man, which nevertheless at the beginning of the century caused immense loss of life around the shores of Lake Victoria [3]. It does not seem to be of much importance as regards live stock.

Other Species.—(*a*) *G. brevipalpis* is widely distributed in Tanganyika and Kenya, but is local in occurrence. It is based on dense wooding, or has a linear distribution, such as in the heavy forest on streams. This species is a carrier of the trypanosomes of domestic stock. (*b*) *G. austeni* occurs in Tanganyika and Kenya in heavy wooding in the coastal areas and some distance inland. It is likely to prove of importance where it is in contact with stock. (*c*) *G. longipennis*, a semi-desert species, hardly occurs in Tanganyika and has not been studied by the Tsetse Research Department. It is found more widely in Kenya, where it has received attention from Lewis. (*d*) *G. fuscipleuris* is found in Kenya and Uganda, where it occurs in small restricted areas only. (*e*) *G. fusca* and (*f*) *nigrofusca* are found in

Uganda in a few localities only, and are really West and Central African species rather than East African.

Reclamation that can be Undertaken with To-day's Knowledge

*Contact between cultivation steppe and the fly-bush**

The Situation.—In some parts of Tanganyika the population is of such density that it is able to keep most of the bush repressed. The Lake Province of Tanganyika provides typical examples of cultivation steppe of enormous extent—vast rolling plains which are so denuded of trees, except the baobab, that firewood is often a real problem. Nevertheless islands of bush of various types do occur and are found in greatest frequency towards the perimeter of the steppes. *Dichrostachys glomerata* grows in great clumps and masses, gall-acacias may be present as groves of full-sized trees or massed together in the low, spindly form they assume when little thinning is done by the natives and close grazing has kept out fire, and in rocky places are seen quite extensive patches of the type of thorn-bush of which the neighbouring fly-bush is composed. Cultivation steppe is not, however, confined to the thorn-bush country. It is common also in the *miombo*, though on a much smaller scale. The area about Tabora is a typical example. At the contact of the steppe and the fly-bush is a no-man's-land, where an incessant war is waged between man and the tsetse. The struggle is most acute where *G. swynnertoni* and *pallidipes* are the tsetses concerned, least so, where *morsitans*, which tends to retreat in the face of man's activities, is present. This no-man's-land is a strip of tsetse-infested bush of variable width and is the transition from the steppe to the virgin savanna, formed by hut builders in search of poles, charcoal burners and villagers cutting firewood; it pursues a winding course, in one place thrusting forward into the steppe as a mighty peninsula which infests the cleared land on each side with tsetse, in another place receding into a bay which, though treeless, may yet be filled with tsetse from the commanding flanks of bush.

The never ending struggle sways to and fro, ruled by forces quite beyond the powers of the individual squatter to control. Where the population pressure is great the no-man's-land may merely be a stage in the conversion of tsetse-bush to cultivation steppe. Only too often, however, the reverse is the case and the tsetse advances. The border villages, though mostly situated in the open, are regularly fed with tsetse-flies by a multitude of persons from the cultivation steppe—not merely the local inhabitants—returning from the bush from cutting timber and grass, and from searching for honey and hunting game. Where the traffic is large and where regeneration has been allowed to spring up in *shambas* or elsewhere, affording tsetses refuge, though not yet breeding sites, the cattle owners tend to suffer losses and leave, thus throwing further land out of cultivation. The regeneration grows into fly-bush proper and tsetse-flies breed in what was once cultivated land. More land is threatened and falls and an advance sets in which may be most difficult to stem. This of course is not the only way in which an advance may start; other factors or complex of factors may play a dominating or contributory part. It will suffice to list a few of the more common causes. Land becomes worn out and deserted and the bush grows up and is invaded by tsetse; an unpopular chief or headman comes into power and his population diminishes as a result of emigration to more popular neighbouring chiefs; water supplies may dry up; a portion of the country may be unlucky in its rainfall for several years in succession or the depredations of animals from the fly-bush—lions, pigs, or even birds—may become so troublesome that the people leave that part of the country. Cultivation steppe is maintained artificially by the pressure of population. The roots of the trees and shrubs, supported by coppice growth, remain alive below ground for many years. When land is no longer hoed, thorn-bushes no longer cut for cattle bomas nor firewood collected near the homesteads, the bush soon springs up again. With the exodus of the people, in swarm the tsetse, ever ready to invade new lands.

Swynnerton [4] has given first-hand evidence of such an advance in his account of conditions at Shinyanga in the early nineteen-twenties. In passing, it is apposite to note that the natives were even losing their hold on one of the main water supplies of the district, the Mhumbo river. They had by no means regained full command of the river when I came to Shinyanga a decade later.

But it is not only at the immediate contact of the fly-bush and the cultivation steppe that

* Cultivation steppe. An open area under sufficiently close human occupation, agricultural, or agricultural and pastoral, to have been cleared of the greater proportion of its natural woody vegetation.

the danger lies. Under certain conditions the tsetse is able to leap forward literally miles at a time. For example, rocky land unsuitable for cultivation, abandoned worn-out land, or perhaps land not fully occupied for some other reason, situated a distance of miles inside the cultivation steppe, may gradually develop a bush-covering sufficient to offer shelter to tsetse carried by persons returning from the fly-bush. The area gets a bad reputation and it and its environs are avoided. The growth increases and eventually the area becomes a true habitat and breeding ground for the tsetse-fly. Now the cultivation steppe sandwiched between this bush and the original contact line becomes untenable and the tsetse is found to have made a great stride forward. Conditions substantially similar to these arose at Ilola in the Shinyanga district. In 1933, when the Tsetse Department intervened, the people were deserting an area fifteen miles long, situated two miles and more from the original contact and separated from it by an *mbuga* (more or less open grass—covered alluvium seasonally swampy). The *mbuga* was largely still open, but carried in places trees of a kind which, though unsuitable for the breeding of tsetse, yet permitted their wandering. This bush may have sprung up through the close grazing of the *mbuga* and the consequent cessation of grass fires. The vegetation on the area itself had grown up to the point of sheltering tsetses, but not breeding them. There was a great passage of people to and from the extensive cultivation steppe to the south and this fed the area continually with tsetses. The remedy lay in clearing the blocks of gall-acacia from the *mbuga* and thus diminishing greatly the numbers of tsetse crossing by their own volition and those carried by persons. Later a fly-picket was installed on the main path from the bush. These measures resulted in such a diminution of tsetses in the area itself that it soon started to fill up again with people and consequently the bush gradually was reduced. To-day the area is safe and the *mbuga* freely grazed by numerous herds of cattle.

The remedy.—Many years ago the author suggested that an effort be made to "freeze" the line of contact of tsetse and man by the demarcation of what he called "defence lines", indicated perhaps by parallel plough furrows a thousand yards apart or by other permanent physical features, which would form the boundary beyond which tsetse would not be permitted to advance. If regeneration of bush between the lines was reported, the population behind, available in considerable numbers—for cultivation steppe is the essential feature of a dense population—would be mobilized to cut back the bush that had sprung up between the "defence lines" and at any place beyond them and thus nip the incipient tsetse advance in the bud. In this way the tsetse front would be stabilized and it would be certain that no more land, from the time of the introduction of the "defence lines", would be lost to the tsetse. Any change would be a change in the right direction—land gained from the tsetse. The author again advocated this policy at the Central Province Development Conference held at Dodoma in February, 1942; it was accepted and embodied in Resolution No. 4. Mr. Hornby, late Director of the Department of Tsetse Research, arrived at the same conclusion independently and began to apply the method around the great experimental blocks at Shinyanga. The policy has been continued, and to-day over many miles the bush-edge stands sharply defined like a wall. It must not be thought, however, that the tsetse halts abruptly at the bush-edge. On the contrary, it will wander far into the cleared area, its range depending on the density of tsetse in the bush, the species concerned, season, etc. The completely cleared strip must be sufficiently wide to prevent any but a few wanderers gaining the other side and finding refuge in the regeneration, shade and fruit trees, and tall crops of the adjacent cultivation steppe. An expert will be required to judge where defence lines are necessary, of what width they should be and to keep an eye on the growth of bush in the settled area beyond them.

Work at Shinyanga has shown that 500 man-days are required initially to slash back one mile by 500 yards of regeneration from ordinary savanna thorn-bush. On that basis defence lines 1,000 yards in width would require 1,000 man-days per running mile, but in practice such a width would extend into the more open cultivation steppe and the figure would probably be nearer 750 man-days. In succeeding years the cost decreases, and as the tree and shrub roots gradually weaken, the whole area begins to turn into grassland.

The Thorn Savanna infected by G. swynnertoni

The situation.—The dry thorn savanna, which may occur as several types, is the true habitat of *G. swynnertoni*. Any attack on a type of this bush implies an attack on the very heart of the problem. Success is, therefore, of

great importance and may also point the way to successful attack on other types.

The remedy.—An island of bush (5A) at Shinyanga, 7,680 acres in extent, infested with *G. swynnertoni*, has been reclaimed by "discriminative clearing", settlement being negligible. Neither fire-exclusion, nor organized grass fires, nor thicket cutting played any part in the measure.

The tsetse-fly requires a concurrence of vegetational types. If one or more vegetational types necessary to it are destroyed by discriminative clearing, then the tsetse cannot live. In this area, over a period of two years, the easily felled vegetation of the hardpan* was cut down. This was followed by an enormous reduction in the number of *G. swynnertoni*. By the third year tsetses were very scarce indeed and in the fourth they finally disappeared from 5A altogether. Very light settlement was present throughout, but it is not believed that it played any significant part; this view is supported by evidence from later work. Pioneer settlement and cultivation, which generally choose the riverine areas first, were of value in keeping down regeneration, though regeneration is in any case slow on hardpan soils. Slashing of regeneration has never been necessary in these areas. The felling of the hardpans cost only one and one-third man-days per acre over the whole area.

Thanks to the co-operation of the Medical Department an opportunity for practical reclamation presented itself on the Ukerewe peninsula. Hardpan clearing was very broadly applied in order to reduce as quickly as possible the toll in human lives which sleeping sickness was taking. No fire-exclusion or organized burning was used. The first hardpans were cleared in 1940. By the end of 1942 75,500 acres (118 square miles) of the peninsula had been treated by this method, involving the clearing of 4,600 acres of hardpan, or only 6 per cent of the total area of bush. The labour cost has worked out at half a man-day of tribal labour per acre, calculated over the whole area treated. The westernmost fly-rounds, where operations were commenced, now frequently produce no tsetses at all; one of them has shown none for the last eight consecutive months, another for the last four. All rounds are very low. Sleeping sickness is quickly disappearing. In 1940, 169 cases were reported, while in 1942 there were only 18, and in the first four months of 1943 there have been none.

Application of the method under other conditions

In some parts of Tanganyika, areas of cultivation or tsetse-free country occur, separated from each other by bands of fly-bush of moderate width. This has the effect of handicapping communications and increasing the length of tsetse-front to the area occupied.

The obvious remedy lies in doing everything possible to combine the settled areas. Where the breadth of the intervening tsetse-bush is not great it may suffice merely to see that all expansion takes place in the required direction, so that a junction is eventually made, or to organize tribal "turn-outs" of labour to fell the bush, taking care not to clear more land than can be absorbed and settled. The stretches of tsetse-bush, however, will often be too large to tackle by these methods with any expectation of their elimination within a reasonable time, and if the settlements are not to remain handicapped indefinitely, other measures must be sought. At Shinyanga, a peninsula of bush infested with *G. swynnertoni*—Block 5B of 8,320 acres—protruded in the settled areas. The same discriminative clearing methods were employed as in Block 5A and the tsetses were enormously reduced to a very low density, although one side of 5B remained in full contact with the main tsetse-bush. Settlement immediately entered along the cleared drainage lines and no slashing of regeneration has ever been necessary. Thus the proportion of highly infested tsetse-front has been much reduced and communications have been improved.

Thorn savanna and miombo *wooding infested by* G. pallidipes

G. pallidipes is ultimately dependent on thicket and therefore it is only where thicket is found in thorn savanna and *miombo* wooding that this tsetse occurs. All thicket is not, however, equally suitable for *G. pallidipes* and the climatic conditions prevailing in a particular place will determine what thicket is essential and what is not. Research has not

* Hardpan. Name given to the narrow strips of hard, light-coloured non-cracking soil on a calcareous or murrum substratum, found along the drainage-lines of much of the thorn-bush. These soils become waterlogged in the rains. Hardpan is always characterized by a poor grass growth with many bare patches and it is clothed with well-defined plant associations containing many soft-wooded and easily felled trees, e.g. *Lannea* and *Commiphora*.

yet gone far enough to permit of fine distinctions being drawn, and this means in practice that with to-day's limited knowledge it will generally be necessary to remove *all* the thickets. In some cases this is perfectly feasible at a small cost. In a block of *Acacia-Commiphora* savanna at Shinyanga the cost came to one and two-thirds man-days per acre calculated over the whole area. In other cases the cost will be very much heavier. A particularly successful and useful piece of reclamation has been done at Mpwapwa, the headquarters of the Tanganiyka Veterinary Department. Here H. E. Hornby reduced the *Combretum* and thicket bush, by clearing, to an open parkland carrying a good grass growth, a policy which has been continued by his successor, the present Director. The farm is fortunately situated in a basin surrounded by steep, tsetse-free hills, thicketed on their lower slopes, which almost turned the basin into an isolated island of tsetse; once rid of its own tsetse population it could not easily be invaded by wandering tsetses from outside. This freedom of the steep hillsides is an important fact which has been observed elsewhere.

The great plains carrying a lace-work of vegetation infested by G. swynnertoni *and* morsitans

For the purpose of this paper the great plains are divided into two classes, those of the gall-acacia type and those mainly with a different bush constituent. The Tsetse Department has successfully solved the problem of the gall-acacia type, which can be reclaimed to-day with certainty of success, cheaply and with small maintenance costs. With regard to the second type, it is certain that the Department has the answer and practical reclamation is pending, though no actual scheme has yet been carried through.

The gall-acacia plains

The situation.—The great black cotton soil gall-acacia plains have many open patches, but they carry a lace-work of *ilula* (gall-acacia bush) which extends right through them. Occasional island rises of small extent are sometimes clothed in typical *G. swynnertoni* thorn-bush. Tsetse-flies are incapable of breeding in the *ilula* lace-work, but they find their way into it, and wander through it, from their "true home", which is the typical thorn-bush on the eluvial ground bordering the plains and the islands mentioned above. Tsetse are naturally more numerous near the edge of the plains in the neighbourhood of their "true home" than towards the centre, and when the distance is very great or open patches extensive enough, only occasional tsetse-flies are found and cattle may graze in comparative immunity. But this condition may be modified by the islands of typical fly-bush mentioned above. They form breeding foci from which tsetses wander out and infest the *ilula* bush for many miles around.

The remedy.—Reclamation is carried out by severing the connexion between the *ilula* bush of the plains and the surrounding "true home", and destroying the "breeding islands" in the plains. At the junction of the *ilula* bush and the "true home" there is generally a lightly bushed hardpan interzone where one bush type gradually merges into the other. If a mile wide clearing is pushed along this junction, parting the two bush types, the *ilula* bush of the plain is segregated and tsetses cannot enter it. The small islands of breeding bush in the *ilula* may be dealt with by sheer felling, and with the provision of water by digging hafirs (tanks), or dams if the fall in the country is sufficient, cattle-owning settlers are only too glad to make their home there, and keep regeneration in check. Pickets must be posted on any much-used paths from the fly-bush to de-fly travellers entering the plains.

In the Shinyanga and Kwimba districts of the Lake Province, where *G. swynnertoni* and *pallidipes* are present, 160,000 acres of the infested portion of the Huru-huru series of mbugas have been reclaimed by this means. The initial cost, including the complete felling of the breeding islands, amounted to the very reasonable figure of one-third of a man-day per acre, calculated over the whole scheme. No maintenance was done during the first nine years, though it should have been started somewhat earlier. Maintenance against tsetse will work out at one eightieth of a man-day per acre per annum, calculated over the whole area. Many thousands [5] of head of cattle now graze the area seasonally, and villages have sprung up on the borders of the plain and the former breeding islands; these areas, now equipped with tanks, are able to carry the stock through dry periods in the rains, and their human population with milk-cows and small stock through the year. Whether in future an attempt will be made to supply water in the plains in such quantities that grazing will be possible all the year round depends on the policy threshed out by the Veterinary and Agricultural Departments. This cheap reclama-

tion scheme has already been of immense value to the Shinyanga district and will become, as the years pass and still fuller use is made of it, an increasingly valuable asset. There still remain approximately 130,000 acres of the Huru-huru gall-acacia plains to be reclaimed when required. Other small areas have been reclaimed in like manner in the Lake Province.

In the Kondoa district of the Central Province a similar scheme is in the course of being developed to enable the Warangi to make use of the many thousands of acres of the Masai steppe that lie in their district. The chief tsetse is *G. morsitans*, though *swynnertoni* is also present in numbers. There is no doubt at all that success will be achieved against *G. morsitans*, just as it has been in the Huru-huru against *swynnertoni*.

Other plains

The situation.—The second type of plain differs from the gall-acacia type in its soil and vegetation. Much of the soil is of the non-cracking calcareous plains type, and while there are stretches of *ilula* bush, the chief constituents are *Acacia campylacantha, A. spirocarpa* and *A. nefasia*; in some areas *A. hebecladoides, Hyphaene* palms, *Commiphora* spp. and *Balanites* sp. are also often present. Rivers carrying *G. pallidipes* thicket may wind their way across the plain.

The remedy.—The method of treatment is a modification of that used for the gall-acacia plains. Where there is contact between the bush of the plains and that of the surrounding fly-bush, a clearing must be interposed between the two as before. But treatment must go further than this. Any *Acacia* tracts in the plains themselves that could independently support tsetses must be dealt with. These tracts correspond to the fly-islands found in the gall-acacia type of plain and act as foci from which the surrounding bush is infested, but they are less well defined. The aim must be to render the plains vegetation utterly inhospitable to the tsetse-fly. This is effected by discriminative clearing, but it will take an experienced officer to decide exactly what bush constituents must be cut out and what can be safely left. If *G. pallidipes* is present, the thickets on the rivers will have to be removed. This type of clearing is dealt with more fully in the next section.

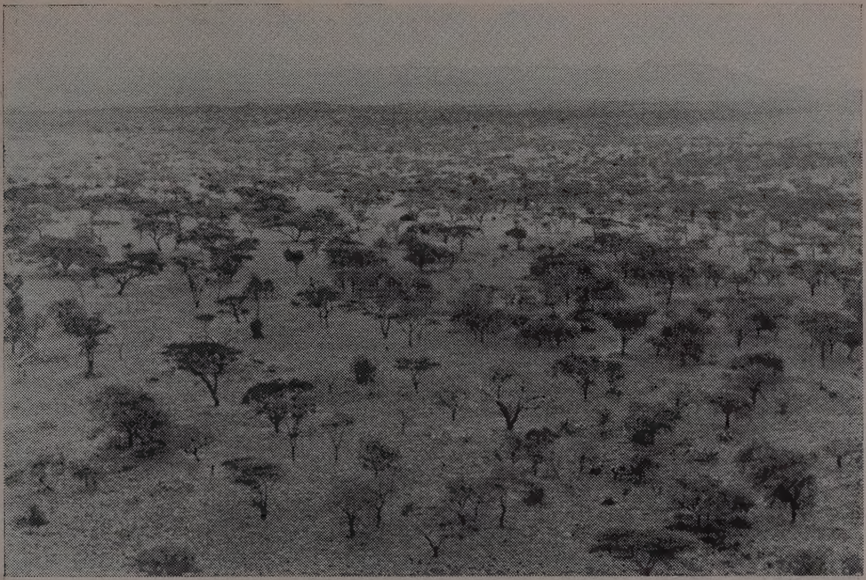
The Department has not yet reclaimed plains of this nature, but a careful survey has been made in the Lake Manyara region of the Northern Province and a scheme of reclamation worked out. From the wide experience of the Department there is no doubt that success will be achieved. The tsetse present is *G. swynnertoni* and on the thicketed rivers *pallidipes* is found. In many places the bush of the plains is already segregated from the surrounding fly-bush by natural, wide treeless stretches. It is estimated that the initial cost of reclamation will be half a man-day per acre over the whole scheme, with the negligible maintenance cost of one three-hundred-and-thirty-third of a man-day per acre per annum. This area is representative of enormous tracts in the vicinity which can be reclaimed when required, though initial and maintenance costs will be higher where a greater proportion of *G. pallidipes* bush exists.

On occasion it may be necessary to make a cattle corridor, by means of a clearing, through the "true home" of the tsetse to give access to the reclaimed plains, but it is simpler and cheaper if this can be avoided, as it can be when even a small portion only of the border of the plains lies up against country already settled. In the early days the eastern side of the Huru-huru plains was served by such a corridor, 1,200 yards in width and over eight miles long, though the north-east of the plains lay open to the cultivation steppe. The road down the middle of the corridor was 600 yards from the fly-bush on either side and this distance was by no means sufficient to prevent tsetses in some numbers from invading it. When cattle were to be passed through, departmental fly-boys made a "sweep" along the road and thus attack was reduced to very small proportions. To-day so much of the intervening country has been reclaimed that the corridor, as such, has passed out of use.

The linear habitats of G. pallidipes, brevipalpis, austeni *and* palpalis

There are certain species of tsetse which, where conditions are favourable, live dispersed through the general woodland, but which under other vegetational conditions are forced to live as a linear community in the deeper shade of the riverine and drainage lines bush. The fact that at some seasons of the year they may be able to wander from their river habitat does not alter the fact that they are ultimately dependent upon it for their existence. *G. pallidipes, brevipalpis* and *austeni* are examples, and of these *pallidipes* is by far the most important.

G. palpalis, the carrier of the *gambiense* type of sleeping sickness, is another tsetse which is



Acacia savanna on the Serengetti

Photo by B. D. Burtt

Acacia drepanolobium (gall-acacia, *ilula*) on the reclaimed Huru-huru plains at Shinyanga, formerly infested with *G. swynnertoni*.

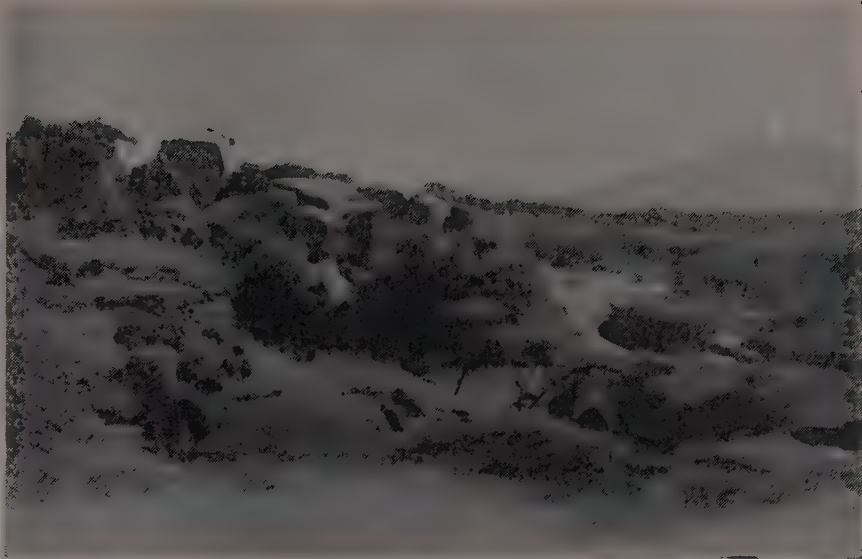
Photo by A. Fisher

A typical hardpan in *Acacia-Commiphora* savanna at Shinyanga.

Photo by AUTHOR

Heavily bushed river-courses in northern Serengetti, draining a *Combretum savanna.*

Photo by B. D. BURTT



The *Acacia-Commiphora* savanna of the experimental area at Shinyanga, infested with *G. swynnertoni.*

Photo by B. D. Burtt

A cleared hardpan, 150 yards wide, in the Shinyanga fire-exclusion area, photographed more than a year after felling. Note the negligible regeneration, a most important point.

Photo by A. Fisher

Isoberlinia-Brachystegia wooding (*miombo*) at Abercorn in Northern Rhodesia, the haunt of *G. morsitans*. It is here that a large-scale fire-exclusion experiment *cum* felling of certain drainage lines is proving very promising.

Photo by B. D. Burtt

Kenya Coastal Thicket infested by *G. Pallidipes*, *G. brevipalpis* and *G. austeni*. The undergrowth cut out.

Photo by J. Y. Moggridge

confined to a linear habitat, haunting the borders of lakes and rivers.

Riverine vegetation infested with G. pallidipes, brevipalpis *and* austeni

The situation.—The Makayuni river, which crosses the Great North Road south of Arusha and meanders across the plains into Lake Manyara, supports a considerable population of *G. pallidipes* in the cool shade of its high *Acacia stenocarpa* trees with thicket understorey. No doubt under certain conditions *G. pallidipes* wander and are carried into the adjacent thorn-bush of the plains, but there is not the slightest doubt that these tsetses are ultimately dependent on the riverine vegetation. The plains vegetation, almost devoid of thickets, does support *G. swynnertoni,* but it cannot support *pallidipes*. The Senje river at Arusha is another example of the same kind of linear infestation.

At Kingolwira, in the Eastern Province of Tanganyika, the Ngerengere river is infested with three species of tsetse—*G. pallidipes, brevipalpis* and *austeni*. Under the conditions ruling there *G. pallidipes* can live in the thickets away from the river, and in this example are not included in the discussion, but experiments have shown that *brevipalpis* and *austeni* are absolutely dependent on the heavy vegetation of the river and well-defined drainage lines.

The remedy.—Where conditions outside the riverine strip are inimical to *G. pallidipes, brevipalpis* and *austeni,* the remedy lies in cutting out the undergrowth and smaller trees, leaving merely the large clean-stemmed trees, presenting a park-like appearance. The object should be to replace the scrub with grass.

At Kingolwira this succeeded against *G. brevipalpis* and *austeni* on the Ngerengere, which carries riverine forest. The initial cost of clearing amounted to twenty-five man-days of convict labour an acre.

G. palpalis

The situation.—*G. palpalis* is very seldom found far from the lake shore and streams running into the lakes. This dependence makes it a comparatively easy species to exterminate for its habitat is very limited.

The remedy.—Foreshore and river clearings will kill out *G. palpalis*. As lake-side and river sites are areas favoured for settlement by populations expanding in numbers, no doubt much of *G. palpalis* country can be reclaimed by properly directed settlement. Symes and Vane [6] have shown in Kenya that *G. palpalis* can be reduced in the riverine bush, by the "Block" method of catching out, to such an extent as to allow human occupation with safety. This method is very much cheaper than sheer clearing and would no doubt play an important part in any campaign. It seems too that the method might be equally successfully applied to the lake shore. [7]

Small villages isolated in the great expanse of the tsetse-bush

The situation.—Scattered throughout the great areas of tsetse-bush are found small isolated villages. In some cases these villages represent remnants of the population which have resolutely refused to retire when their country has been invaded by tsetse, but in the majority of cases they are no doubt communities which have gradually spread out from the mother settlement, since the introduction of ordered Government made such a step possible and safe. These little settlements are difficult and costly to administer and it is almost impossible to bring them the benefits of medical attention, education and agricultural teaching. But there is a still more serious aspect. The Medical Department of Tanganyika has found that "When the population is as low as one person to the square mile the people are too dispersed to be able to sustain an epidemic, while with a density over twenty-five persons to the square mile there is, automatically, enough destruction of bush for purposes of tillage to cause some reduction in the fly population. When a density of fifty to eighty is reached the country is generally sufficiently clear to be practically fly-free". [8] As Rhodesian Sleeping Sickness already infects a large part of the tsetse bush of Tanganyika and is rapidly extending its boundaries, it became essential to introduce some measure to control the isolated villages.

The remedy.—The Sleeping Sickness Branch of the Medical Department of Tanganyika has successfully evolved a remedy. Scattered communities have been gathered into settlements of not less than one thousand taxpayers (3,000 to 4,000 souls), which carve for themselves great clearings out of the surrounding tsetse-bush. This serves to sever the connexion between the tsetse and the population sufficiently to control the disease. Medical attention, administration, education, etc., now become possible. A good agricultural practice must be introduced to make these settlements permanent, and this is receiving attention. The

line of contact between the settlement and the tsetse-bush must be carefully watched and what has been said on the contact between cultivation steppe and tsetse-bush applied equally here.

Tsetse in and round towns

The situation.—Where a town is surrounded by *miombo* wooding infested with *G. morsitans*, or thorn savanna with *swynnertoni*, or either of these vegetational types with *pallidipes*, odd tsetse-flies will always be carried in and may do a great deal of damage. Virgin *miombo* and thorn-bush are, however, rarely, if ever, found actually on town lands. Long ago the trees have been cut down for one purpose or another and the land has been hoed for *shambas*. In shifting native cultivation the land must lie fallow for several years to regain fertility, and during this period many of the roots and stumps of shrubs and trees, which have remained alive in the ground through the cultivation phase, push out new shoots, and clumps of thicket appear. The thicket grows up and gradually a *G. pallidipes* habitat is formed, which, if that very widely distributed species of tsetse is present in the neighbourhood, quickly becomes infested by it. Thus the two factors—the kind of vegetation formed on town lands and the wide distribution of the very tsetse that can make use of that vegetation—combine to ensure that some of the township areas of East Africa are infested with *G. pallidipes*, one of the most important vectors of animal trypanosomiasis. Dar es Salaam and Tanga are examples that immediately spring to mind in Tanganyika Territory. *G. brevipalpis* and *austeni* commonly occur with *pallidipes, particularly* in the coastal belt, and are dangerous to stock, but it is not necessary to deal with them separately, for the measures that destroy *pallidipes* will eliminate them too.

The remedy.—The carriage of tsetses into a town from outside can be diminished by posting de-fly pickets on the main thoroughfares leading into the town.

As regards tsetse-flies breeding within a town area, let it be said at once that to-day there is no technical reason why town-dwellers should continue to tolerate such a state of affairs—so detrimental to the health of the community, to the poor milk supply, and to economic life generally. The position has been carefully studied by technical officers of the Department and the remedy is simple—it entails merely the cutting out of the thickets without interference with the large trees. Although the measure is advocated everywhere, it will be particularly effective on the coast, where Moggridge [9] has shown that the climatic conditions greatly restrict the power of *G. pallidipes* to roam.

A careful examination of the position at Dar es Salaam showed that the main town grazing areas are 31,250 acres in extent. It would require approximately 110,000 man-days of the poor quality, local labour to slash down the thicket on that area. If this unskilled labour received 60 cents per diem the initial cost of the scheme, not including European supervision, would amount to £3,500. Regeneration in the first year would be heavy and £600 might be necessary to deal with it. Thereafter it would become less and less as the roots of the thickets yielded to the unrelenting slashing of the aerial parts. Besides freedom from trypanosomiasis there would be an immediate gain to the cattle-owning community in increased grazing—as grass replaced the thickets; it would become possible to improve the pasture and to introduce better quality stock. Wherever the £3,500 is to come from, it is not a large sum to pay for the benefits which would accrue to the whole community, and not least to the cattle-owning members themselves. The fact that much of the land involved is alienated makes it difficult to devise a practicable and fair scheme of allocation of the cost. A cattle tax, which it is believed the dairymen of Dar es Salaam could easily bear, has been suggested. But the writer now agrees that the best method is to put the onus of clearing his land of tsetse—where, as in Dar es Salaam, attack comes from within—on the owner of the land, with proper provision for financial assistance if required. It is certain that piecemeal action would be of little avail. It will not help a man to clear his own land if his neighbour does nothing. The possibility of legislation on these lines is being explored by Government and the matter is discussed further in the paragraph on legislation.

Alienated Land

The problem of alienated land, in areas where a great proportion is planted or cleared of trees and under the plough, may be very similar to that of townships, though on a larger scale; and the position can be met in a similar way. In other circumstances where the alienated land, though bushed, is so fortunate as to be surrounded by a protective belt of relatively unfavourable vegetation—as has been found in the Arusha area—it may be possible to remedy the position by clearing the

distant concentration sites. Elsewhere the farms will be covered with wooding favourable to the tsetse-fly; indeed conditions will approach those of the virgin fly-bush. In such cases it will be much more difficult to devise suitable measures. But the position will by no means necessarily be hopeless, though there will certainly be places where little can be done in the present state of knowledge. The tsetse adviser has a battery of proved weapons from which to choose—extension or amalgamation of naturally open or already cleared areas, discriminative clearing to relieve the "tsetse pressure" at determined points, destruction of main foci by clearing, thicket cutting to deal with *G. pallidipes* and the setting up of pickets to prevent tsetses being carried into the developed parts. In some places it will be possible to accomplish much, in others very little. But it will always be worth while for the owner to ask for advice.

In all cases where alienated land is involved it is essential that there should be the necessary legislation to back up whatever measures are proposed by Government and accepted by the majority of the owners concerned. Action by the individual will alleviate the position but little; there must be action by all and there must be means to force the recalcitrant individual to co-operate for the benefit of his community. This of course implies that Government itself should do its share where Crown Lands are involved and that the Native Authorities should also co-operate where treatment of occupied native land is necessary to the success of the scheme.

Two other reclamation methods

The following two methods will probably entail the use of barrier clearings. Stress is not laid on them because the object to-day is to avoid as far as possible the cutting of barriers, which are ineffective unless very wide, and are expensive to maintain.

Reclamation by organized grass fires.—A method of reclamation, suitable for fairly open, long-grass country and used in the early days at Shinyanga against *G. swynnertoni*, was that of holding up the grass fires until the heavy winds of the late dry season, and then sweeping the island of bush with a fire put in simultaneously along the whole windward side. Direct destruction of tsetse ensued and the object was to drive the remaining tsetse over the leeward clearing, thus preventing their return to the block. This measure will still no doubt retain a subordinate place among the weapons available to the reclamation officer, either for use alone or supplementary to another method. One important footnote must, however, be added. Thicket and short-grass hardpans were found to break up the line of the fire and act as refuge islands for the tsetses, and thus reduce the efficacy of the measure. It was therefore concluded that thickets and hardpans would have to be cleared. In the light of to-day's knowledge, was it the clearing of the hardpans and not the fire that rid the areas of tsetses? There can be no doubt that the fire caused a holocaust and hastened results, but was it the main factor?

Isolation of special vegetational areas.—A description is given of the reclamation of the Huru-huru gall-acacia *mbuga* by placing a clearing between the plains and the surrounding "true home" of *G. swynnertoni*. Before reclamation *G. swynnertoni* could and did wander through the gall-acacia plains, but they could not breed in them. Similarly there are other vegetational types, such as pure stands of *Combretum* spp. and long-grassed *Acacia spirocarpa* country, which are unfavourable to *G. Swynnertoni*, although *swynnertoni* will wander through them. Such areas—and very extensive stretches are found—can be reclaimed by interposing a cleared barrier. Blocks 7A and 7B in Shinyanga were reclaimed by this means.

LEGISLATION

The important question of legislation has already been touched on several times in previous paragraphs. It is not intended to lay down here in detail what new legislation is necessary. The matter is in the course of being threshed out by Government for Tanganyika. But it is necessary to mention what legislation already exists and to indicate the general line which, it is thought, new legislation should follow. Legislation is the corner-stone on which a properly co-ordinated and organized reclamation policy must rest.

Legislation for sleeping sickness control

Sleeping sickness control by the Medical Department is carried out through the medium of orders under sections 8 (*g*), (*j*), (*o*) and (*r*) of the Native Authority Ordinance, reinforced if necessary by regulations under the Master and Native Servants Ordinance for the control of labour recruiting in affected areas. These sections cover the prevention of spread of infectious or contagious disease, regulation of migration of natives, and orders for the purpose of exterminating or preventing the spread of tsetse-flies.

Legislation for regulating traffic to and from areas infested with tsetse-flies

A Bill for Tanganyika has already been drafted for this purpose, based on the Southern Rhodesian model. Foot traffic has always played an important part in disseminating the tsetse, but with motor traffic the danger becomes very much greater. Few people would care to put a limit on the maximum distance which individual tsetses may be carried by motor cars—they certainly stay with a car many hours. They can be carried shorter distances in great numbers. Swynnerton [10] wrote that when the Shinyanga–Mwanza road ran through a fly-belt, *G. swynnertoni* "were carried in fifties and hundreds to forty miles and more into the open country to the north by numerous lorries and cars daily". It is essential, then, to place the existing fly-pickets and the new pickets which a forward tsetse policy would make necessary, together with the more elaborate de-flying houses which may be required at key points, on a proper legal footing to ensure that the pickets are not "crashed". By this means the spread of tsetse, perhaps to form new belts, certainly to cause losses far from the mother-belt, can be controlled. Other clauses to deal with the restriction of traffic to certain defined routes and times of the day, the prohibition of movement to or from or within certain areas and the interruption of movement at prescribed points.

Legislation for the extermination of tsetse-flies on private land

Legislation on the following lines is being drafted:—

(*a*) The Ordinance to provide for compulsory anti-tsetse measures where a majority of the landowners desire them, or where Government wishes to introduce them.

(*b*) The Ordinance to be framed so as to make provision for combating tsetse originating some distance from the alienated areas, i.e. tsetses wandering on to, not bred on, the alienated areas.

(*c*) Empty Crown Lands or native-occupied areas to come within the scope of any scheme if their inclusion is necessary to its success.

(*d*) Long-term loans to be available for those landowners unable to finance the clearing necessary on their farms.

(*e*) Provision to be made for the maintenance of the anti-tsetse measures.

(*f*) Penalties for persistent non-compliance to be of such a nature that they would ensure the measures being put into effect.

With legislation of the above nature—and Tanganyika is half-way towards the goal already—it becomes possible to put into effect a comprehensive tsetse policy. Such legislation is fundamental to the successful tackling of the problem.

THE PROSPECT FOR LARGE-SCALE RECLAMATION

If large-scale reclamation is arbitrarily defined as reclamation of areas of over 32,000 acres in extent (50 square miles) it is apparent that in some directions, e.g. the reclamation of the great plains, the hardpan *Acacia-Commiphora* country and the other situations described in the preceding paragraphs, such reclamation can already be successfully undertaken to-day. Indeed a report on the Arusha area has just been submitted recommending that 320,000 acres (500 square miles) should be reclaimed from *G. swynnertoni* and *pallidipes* by cheap discriminative clearing. Again a great island area of 190,000 acres (300 square miles) has been surveyed in the Musoma district and there is no doubt that it can be reclaimed cheaply from the *G. swynnertoni, pallidipes* and *brevipalpis* which infest it. In the aggregate there are literally several thousand square miles of Tanganyika which can be reclaimed at a cheap cost by methods already known to the Department.

But satisfactory and encouraging as all this is, it does not mean that the great mass of the tsetse-bush, irrespective of its composition, can yet be reclaimed—the enormous tracts of *G. morsitans*-infested *miombo* which cover so much of East Africa, great areas of certain types of *swynnertoni* thorn-bush and much of the vast *pallidipes* country. The fact that these fly-belts occur in such great, apparently unbroken masses, which, if smaller, might at any rate be attacked piecemeal, makes the problem appear all the more intractable.

In order to obtain a realistic view of the possibilities of attacking such areas and to ensure that any tsetse policy that is adopted takes due account, not only of the reclamation that can be undertaken with to-day's knowledge, but of the advances that have been made in solving this seemingly intractable problem, a résumé will be given of the large-scale experiments, financed by the Colonial Development Fund, which were designed to produce a cheap method suitable for use in extensive areas. These experiments had to be made large in order to include the diversity of vegetation, e.g. riverine bush, hardpan, eluvial bush, etc., which goes to make up any one vegetational type. The war has seriously interfered with the

field experiments. Some of those which had only just been started had to be closed down, and other promising avenues which have been discovered in the course of the work have not yet been explored. The more important of these are included in order to produce a balanced picture.

The Progress of the Large-Scale Field Experiments

The effect of fire-exclusion and clearing of the hardpans on *G. swynnertoni* and *G. pallidipes* is being studied in a large-scale experiment at Shinyanga in *G. swynnertoni* and *pallidipes* bush. When fire is excluded from an area of country the vegetation, normally kept in check by fire or other factors, gradually moves towards its climax which, in the Shinyanga thorn-bush, is believed to be thicket. Herbaceous growth and young trees which are normally burnt back annually now have a chance to grow and the bush thickens. The experiment is based on the fact that each species of tsetse is adapted to its own environment. For example, *G. swynnertoni* inhabits the dry thorn-bush areas and will not penetrate far into the better-shaded mesophytic *miombo*; while *G. morsitans* is, generally speaking, an inhabitant of the *miombo* and will not flourish in bush much denser than that. Thus the object of fire-exclusion is to change the vegetative cover and produce a habitat unfavourable to the species attacked.

At Shinyanga the eluvial areas thickened well and mathematical analysis showed that over most of the country fire-exclusion effected a steady proportionate reduction of *G. swynnertoni*, approaching 50 per cent per annum, under conditions of constant climate. Most of the tsetses that remained were concentrated in the hardpans (see page 6 for description of hardpans). Densification on the hardpans was slow, as it was known it would be. Their borders, bearing a transition vegetation, did thicken, but their centres hardly at all. The hope was that the total hardpan area would be much reduced, thus lessening the amount of clearing that would have to be done in them. The experiment was continued over a sufficiently long period to be sure that the fall was real, not fictitious and perhaps the effect of a succession of unfavourable seasons. A control was maintained. But it became clear that the measure of fire-exclusion alone, as was indeed expected, would not eliminate the tsetse in any reasonable length of time; it would only reduce the population. Reduction is not enough; extermination is necessary. Accordingly the supplementary measure of clearing the hardpans of their bush cover was adopted, the riverine thicket being left untouched. This resulted in a tremendous fall in the remaining tsetse population. At the start of the experiment (1935) the highest monthly mean recorded was over 500 tsetses per 10,000 yards, i.e. six miles; just before discriminative clearing was commenced (1940) the figure was over 60; to-day it has been reduced to two per 10,000 yards and is falling. About 3½ per cent of this block of bush, which was of a composition very favourable to *G. swynnertoni*, has been felled. The last discriminative clearing has only been done recently. The control maintains high figures. It still remains to be seen whether the two measures combined will kill off the last tsetse.

The effect of fire-exclusion on *G. pallidipes* might have been expected to have favoured the species. Actually there is no evidence that it has done so; numbers have not increased. The thickening up of the bush that has taken place apparently does not form the habitat that *G. pallidipes* requires under Shinyanga conditions.

(To be continued)

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"Near the pools I saw an amazing sight; one of the biggest concentrations of cattle I have seen at any one watering place outside Masailand. I estimated there were more than 10,000 head. I am informed that until a year or two ago this part of the Huru-huru was fly-infested, and was entirely without cattle at all times of the year. . . . ."

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THE KIKUYU METHOD OF BURNING CHARCOAL

By L. A. Elmer, Assistant Agricultural Officer, Department of Agriculture, Kenya

The natives of the Kiambu Reserve send large quantities of charcoal to Nairobi. The method of making it was different from any that I had seen before and I tried to find out how the people had learned to burn it. A certain section believed that Indian charcoal burners had taught them, but the majority of those I questioned gave a very probable and pleasing explanation:

They said that the early African smiths were familiar with the use of charcoal which was got originally from charred trees in the forests and then by each smith making a small primitive stack or *muhuko,* similar to the big ones, now customary, except that he excavated to take half the heap of billets of wood and used the earth to complete the covering. This simple but profound description merits belief.

At that time there were about twenty native agricultural instructors working in Kiambu Reserve, of whom only one knew much about charcoal, due to his having worked for a charcoal burner when he was a youngster. In order to stimulate their interest in one of the important industries of the Reserve, I got each man to write an essay on charcoal burning as practised in his area. The description given below sums up their observations.

The method is eminently suitable for wattle timbers and wastage is not excessive if care is taken. It was difficult to assess wastage, as I found that if I suggested it was great the charcoal burner agreed, apparently hoping that the price could be put up! On the other hand, suggestions to other men that the method was economical met with their ready agreement, showing that this aspect of their trade has not yet become very important as they get the wood cheaply by buying a stand of more or less mature wattle trees from natives unable to make charcoal.

The material used is half dry wattle or other poles varying in diameter from 1½ inches to 8 inches and cut into lengths from 4 ft. to 9 ft. as straight as possible. The trees should be dug out as the stumps give the hardest and heaviest charcoal.

All the material should be trimmed clean to allow close packing. Thick bark is removed. Stripping the bark helps to dry out the timber. Even drying means even burning. If some poles are very green and some very dry they should be mixed evenly when building the stack. Thinner branches are trimmed and cut up into suitable lengths varying from 2 ft. to 5 ft. to be used as packing and firing material. These should be dried.

Building the Stack (*Kikuyu* Muhuko)

The stack when built is roughly of the shape of a segment of a cone lying on the larger of its flat surfaces.

The site for the stack should be level or nearly level. A slight rise from the point, apex or front of the stack to the rear or wide end will help the fire to creep.

The floor is marked out with pegs in a roughly triangular shape varying from 1 ft. to 12 ft. wide and from 20 ft. to 30 ft. long.

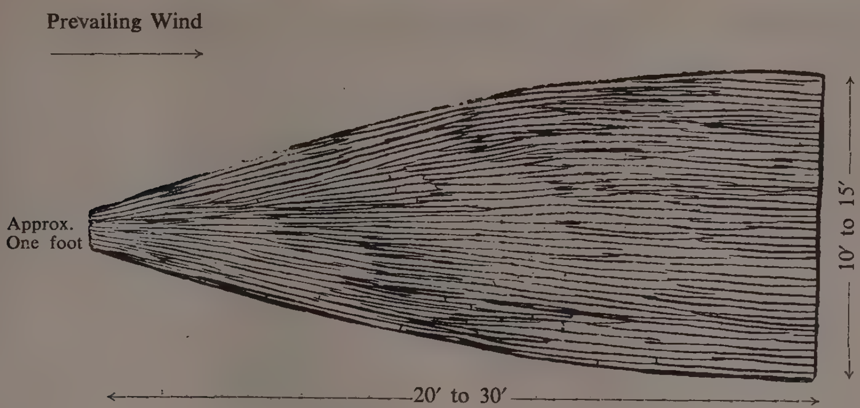
To begin building stout poles are laid covering the ground plan. Each piece is laid with its thinner end towards the apex or front end. The poles should touch and be fairly straight. The poles should in every layer taper from back to front and the ends should touch. No thick poles are laid at the narrow end of the stack, only thin ends 1½ in. to 2 in. diameter.

The ground layer is then packed with straight dry sticks to help the fire to creep. They should not form a layer, but pieces laid end to end should be packed in between the poles. All the material should lie fore and aft exactly.

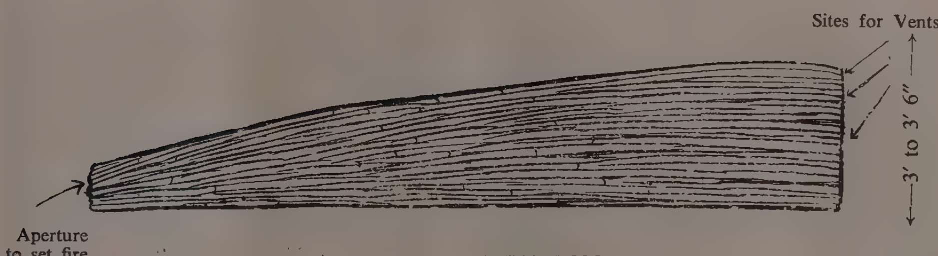
Further layers are placed, thinner pieces of timber being mixed with thicker pieces and an even proportion of dry pieces of thin stick being added. Unevenness in packing must be avoided, the thick, medium, thin and dry material must be evenly distributed and big gaps eliminated. The dry sticks should not normally exceed 5 per cent of the whole and should be more frequent at the front end and sparser towards the rear. Intelligent and careful building is the secret of success. As in laying board floors, lines of joins should be avoided. The front end must be packed also with enough dry twigs and sticks to enable the fire to travel at least one-fifth of the length readily, this material is laid in thin layers and must not be packed with grass, otherwise there may not be a passage for air.

The last layer of poles may be greener and be packed with fresh green sticks, especially at the front end so that the turf covering does not collapse easily when the stack is burning.

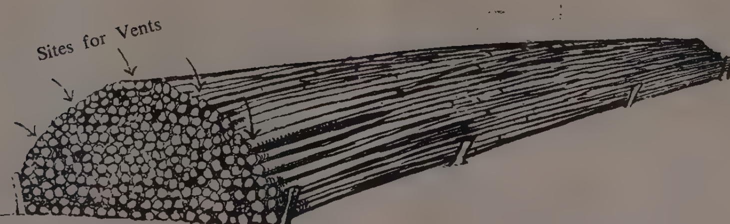
When the stack is being built and when finished it should, at a little distance, give the impression that it consists of long poles laid with their butts at the rear end; actually, it must be remembered, no piece is over 9 ft. long.



PLAN



SIDE ELEVATION



END VIEW

During the building no space large enough to insert the fist should be left unpacked with material.

When the stack is built it is covered with a layer 1 in. to 2 in. thick of short green grass. Brick-shaped sods are then cut and built over the stack from ground level upwards, the grass side being laid inwards. As in masonry work, lines of joins should be avoided. When the stack is covered it is usual to spread a couple of inches of damp soil all over and pack it down firmly to fill up any possible interstices. An aperture about 9 in. by 9 in. is left at the bottom of the front end to admit of the fire being started and four or five small evenly spaced vents (about 6 in. by 6 in.) are left at the top end of the rear.

A small stack of sods and another of damp soil are put nearby to fill up vent holes which will appear in the structure as burning proceeds.

Firing the Stack

The fire is now lit, and when it has caught well, the main aperture, at the bottom of the front, is reduced in size as the fire increases. After two to three hours, when the fire should have travelled about one-sixth of the length of the stack, the aperture is blocked completely.

The row of vent holes at the top rear end of the stack are left open for about half a day. If left longer the top timber is inclined to burn out. In place of these vents three or four more about 4 in. square are made on the floor level (at the rear end) and these are enough to draw the fire to the end, after which they are closed with turf.

Once fired, the stack must be watched day and night, until it is opened. No adventitious vent must be allowed. Tiny wisps of steam and smoke will escape here and there, but any vent shooting out smoke (and eventually flame) must be stopped at once.

The fire may take anything up to 48 hours to reach the far end. If there is reason to suspect that it is dying out a turf may be removed in the middle for inspection and if this is the case small holes should be made near the ground level at each side and at the top until the fire is again going well. Normally this is not necessary.

When closing the vents, do not wait until flames are bursting out but close them as the fire approaches close enough to be seen.

After a period of from three to six days smoke ceases to issue and the stack may be left another two to four days before being opened. During this time the stack may sink a little and great watchfulness is needed in case vents appear which may cause the whole stack to ignite.

The stack is opened at the thin end and as the charcoal is hot it is spread with a stake or shovel, care being taken not to smash it. If the stack is still on fire it must be covered again at once. When spreading the coals, a sharp look-out must be kept for fire, which must be quenched with damp soil.

The charcoal should be watched very carefully when spread out to cool. The heap may be cut up by lines of sods so that if a fire should start through negligence the whole lot will not be destroyed.

Any poles partly charred are set aside for incorporation in a new stack. They are placed at the outside edges. Alternatively a quantity may be collected and built into a new stack consisting of all partly charred material which will burn in about half the time taken by new timber.

Every charcoal burner in Kikuyu has his own variations of the above method. Experience and care will soon enable a burner to learn what is best suited to the prevailing conditions.

Care must be taken not to allow anyone to climb on a stack once it has been fired as he might fall in and be burnt to death.

A stack 25 ft. long, 10 ft. wide by 3 ft. 6 in. high should produce 50 heaped sacks of charcoal. Natives say that 300 thin trees 4 in. to 5 in. butts will produce this quantity.

The work is usually done by gangs of four to five men, who (once they know the work) will construct and burn up to a dozen stacks in the course of a month. A temporary hut is built on the *windward* side of the area set apart for burning and at night one man is always on duty and can call his fellows if he needs help.

The usual method of packing is to fill a sack full up to the top so that the mouth cannot be sewn in the ordinary way. Bracken, wattle twigs and leaves or other suitable green vegetation is laid over the charcoal and tucked down between the coal and the inside of the bag. Thin green wattle bark or other bark or fibre is then placed across to hold the leafy packing in place. The sack of charcoal weighing about 70 lb. is now ready to be transported to market. Sales are usually effected by this "sackful". Transactions by weight are not considered as water or rain can upset the buyers' calculations.

(*Received for publication on 15th October,* 1942)

THE AGRICULTURAL PROBLEMS POSED BY SLEEPING SICKNESS SETTLEMENTS

By H. Fairbairn, M.D.

Before the advent of the European the natives of Tanganyika Territory lived in large, compact settlements. These large settlements were formed as defensive communities; they contained, usually, large herds of cattle obtained by raiding or otherwise; and with the clearing of bush which took place to provide the people with the necessary agricultural land, they formed a positive measure against trypanosomiasis of man and stock. Following the arrival of European rule and the suppression of inter-tribal warfare, the settlements tended to break up, this tendency being accelerated by the German *corvée* system and the demands for porters in the war of 1914–1918. Families left the larger cleared areas and scattered in the bush, living by themselves or in groups of only a few families. In these conditions they were unable to keep cattle, but were themselves healthy. On the introduction, however, of sleeping sickness into such an area of tsetse-infested bush, large-scale epidemics occurred. For a fuller account of this alteration in native life the reader should consult Maclean (1929).

Maclean (1934) has estimated that a population density of five to twenty-five persons to the square mile is most favourable for the epidemic spread of sleeping sickness. He states that: "When the population is as low as one person to the square mile, the people are too dispersed to be able to sustain an epidemic; while with a density over twenty-five persons to the square mile there is, automatically, enough destruction of bush for purposes of tillage to cause some reduction in the fly population. When a density of fifty to eighty is reached the country is generally sufficiently clear to be practically fly free". These figures are correct, but only if "person" is translated as "taxpayer" and thus head of a family group, with a family farm. The native farm is essentially a family affair; and it has been estimated that in the Western Province such a family (which is equivalent to 3.3 persons per taxpayer) cultivates each year about 4½ acres of land. On this basis the density of population can be expressed as follows:—

One taxpayer (3·3 persons) per square mile has 640 acres per family.

Five taxpayers (16·5 persons) per square mile have 128 acres per family.

Twenty-five taxpayers (82·5 persons) per square mile have 25·6 acres per family.

Fifty taxpayers (165 persons) per square mile have 12·8 acres per family.

Eighty taxpayers (260 persons) per square mile have 8 acres per family.

It will be seen that at a density of 25 taxpayers per square mile or less, the amount of land available is too large for the family to clear properly, tsetse flies are still prevalent round the homesteads and in the fields, and there is no inducement to fallow the land, as there is ample room in which to start new farms, with the minimum of clearing.

Sleeping sickness in this territory is mainly due to *T. rhodesiense,* transmitted by *G. morsitans* and *G. swynnertoni,* but possibly also by *G. pallidipes.* It has been proved that an epidemic cannot be controlled merely by the establishment of dispensaries and the treatment of the infected people, no matter how thoroughly this is done, but that more positive, preventive measures are required. (This in line with such other tropical diseases as malaria and hookworm.) The basis of all such preventive measures is the breaking of the contact between man and the tsetse fly, and it has been found that this can only be done by the re-establishment of large, compact settlements, which are completely cleared of bush, so eliminating all tsetse fly. (The areas in which the people are resettled were originally called "sleeping sickness concentrations". It has been found that some Europeans are inclined to think of these settlements in terms of the Axis "concentration camps", and it is now considered advisable to call them "sleeping sickness settlements").

There are various ways by which these cleared areas can be established: (1) The people can be removed completely from the fly bush and resettled in open country—as was done with the population of the Sesse Islands, Uganda, or in Maswa District, Tanganyika Territory. (2) Where the density of population is sufficiently high, clearing of the intervening bush can be done so as to throw the various family groups into one open clearing. (3) Or an area of virgin bush is selected, and a large number of families scattered in the district are collected and resettled in this area.

This third method is the one most usually employed in Tanganyika Territory. In the Lake and Western Provinces the Chiefs are usually

hereditary, and both the Chiefs and people are very jealous of their tribal lands. It would be difficult, if not impossible, to obtain their consent to abandon their country and settle in another Chiefdom, and without a modicum of co-operation from the people any settlement scheme is doomed to failure. Further, the area under tsetse-infested bush is so large that, if all the people were removed from the centre and settled on the periphery of the forest, it would leave very large areas of the country uninhabited and unsupervised, which would act as a refuge for all those who are "agin the government". By establishing one or more large settlements in each Chiefdom, or by resettling two smaller Chiefdoms in one area through which runs the tribal boundary, the country remains administered by the Native Authorities, who are then responsible for seeing that no one lives outside the settlement.

This was the policy originally adopted by Maclean (1930). In view of the redistribution of the population (mentioned above) which was still going on, he did not consider that all the new settlements would be permanent; and he foresaw the possibility that some of them might have to be amalgamated with other successful ones. But this depopulation of the settlements has not taken place, and the present aim is to make all of them permanent and agriculturally sound.

When an epidemic of sleeping sickness occurs, and it is proposed to resettle the people, the following steps are taken:—

(1) The number of taxpayers involved in the area is found. This may or may not necessitate a census, depending upon whether the Native Authority is a strong one or not, upon which depends the accuracy of its tax register. The present policy is that each settlement should have at least 1,000 taxpayers.

(2) As the ultimate aim is to have 16 acres of agricultural land available per family (i.e. per taxpayer) the natives are asked if they know of any suitable sites. It will be found that they often propose one or more sites near the Chief or one the major headman; but as such sites usually include land under regenerating bush fallow, they are not suitable for a long-term resettlement scheme.

(3) The Sleeping Sickness Surveyor, accompanied by several of the elders, then surveys the district to select a block of well-watered land which will allow 16 acres per family in a compact area, as nearly square as possible. During the course of this survey he may find two or more suitable areas, and may be directed to some of them by native information.

(4) The one or more suitable areas found are then put before the Chief and his people in *baraza* (meeting), and by a majority vote they decide which area will be settled.

(5) A well-defined boundary, enclosing eight acres per family, is put in by the Sleeping Sickness Surveyor, and arrangements made to resettle the people between August and October, i.e. after their harvest has been gathered, and at least a month before they have to start cultivating their new *shambas*.

(6) The area is divided up by the Chief (under the general supervision of the Sleeping Sickness Surveyor) amongst his headmen, in the proportion of each headmen's taxpayers. Within the area of each headman his people build their houses and select their *shambas* where they choose.

(7) The people build their temporary homes before and during the move, and they clear the land of all scrub and small trees sufficiently to admit the sunshine to their crops.

(8) In subsequent years by their own endeavour they clear thoroughly their *shambas*, and by communal turnout they clear all trees on land not yet being used agriculturally.

(9) When the original eight acres per family is cleared (and that usually takes eight years' work) the boundaries of the settlement are progressively enlarged and clearing goes on, a majority of the people cultivating in the new land made available, until the whole 16 acres per family has been completely cleared.

(10) By this means, no 4-acre plot need be used for more than four or five years before the people clear and use new land, allowing their original *shambas* to lie fallow.

(11) When once the original eight acres per family have been cleared, there is sufficient clean fallow in the centre of the settlement to allow of cattle being introduced and herded, free from trypanosomiasis. In practice, cattle may be introduced as early as six years after the settlement has started, if the boundaries have

been clean-felled for about half a mile in depth, so cutting off the standing bush in the settlement from the fly-infested bush on the periphery. Small stock (goats particularly) can be, and usually are, introduced from the second year onwards.

(12) A dispensary, with trained dresser and microscope, is established in each settlement.

With regard to point (3)—the selection of a block of *well-watered* land—the position in *miombo** (*Brachystegia*) country is interesting. It is sufficient to be sure that the area has an *mbuga* system (system of seasonal swamps) or river course or other spots where the natives know that water can be found in virgin *miombo*, in sufficient amounts to supply the needs of the people for the first year, even though some of them may have to go as far as two miles for their water. For it has been proved over and over again that when once the tree cover is removed from such *miombo* land the water supply increases enormously, and that wells can be dug and will supply water in places where it would have been impossible to obtain it previously. In any re-settlement scheme it is only essential to be certain of the water supply in the first year, for once the tree cover has been reduced the water will increase and be found all over the area.

In any area selected for settlement it is desirable that one at least of the boundaries should be a natural feature, such as a range of hills, *mbuga* or river bed. The inclusion of *mbugas* is also essential, as giving land for crops which do not grow on *miombo* hillsides.

When the area for re-settlement has been selected and the boundaries put in, the arrangements made for the move (point (5) above) are as follows:—

(*a*) The Sleeping Sickness Surveyor cuts motor tracks to various points within easy reach of the majority of the families to be moved (collecting points).

(*b*) He also cuts tracks in the new area, such tracks usually leading to the places where the headmen are going to settle (unloading points).

(*c*) If gunny-bags are available, these are issued to the people, village by village in turn, and they bag their harvest ready for transport. If bags are not available, the people are told to make up their harvest in bark bundles of about 50 lb. each.

(*d*) At the time of the move the men porter their harvest to the nearest collecting point, as well as their bark granaries, cooking pots, beds and other household goods. These goods, with the aged and infirm and small children, are transported by lorry to the nearest unloading point and are off-loaded and received by a member of the household, who porters it to the newly built house. The bags are emptied and returned immediately.

In this way, by taking village by village in turn, a large number of people can be moved easily and quickly. The table attached shows the costs of recent moves which have taken place in Tanganyika Territory. It will be seen that the most expensive move was where hired transport had to be used almost exclusively, and that the cheapest move was where Government transport was used from the collecting points to the main road and the loads then carried forward to the new area by the 15-ton diesel-engined road train. At a cost varying from Sh. 3 to Sh. 28/37 per person, this is one of the cheapest positive preventive measures against disease in the tropics.

The table also gives some indication of the size of the harvest which the people had.

From the foregoing it will be apparent that the formation of a sleeping sickness settlement is essentially a medical problem in the first few years. People who are scattered in the bush, and who are contracting sleeping sickness, have to be collected and settled in a new area, and that area rendered fly-free (and thus disease-free) as soon as possible. In the face of an epidemic there is no time for the refinement of dividing land into farms, and when it takes so long to clear a large amount of agricultural land there is no possibility of resettling the people on individual holdings. In fact, if the disease is at all severe, it is better policy to include in the original boundaries of the settled area only four acres per family, rather than eight acres. These four acres can then be cleared quickly, and the disease controlled, after which expansion can take place at leisure and free from danger to the health of the community.

It was hoped that the hygienic, economic and agricultural standards of the people would

* The spelling of this word has been the subject of discussion. Etymologically *myombo* (pl. *miyombo*), as given in Greenway's "Swahili dictionary of plant names", is certainly correct. But *miombo* is so well established in ecological literature (cf. Carpenter's "Ecological glossary", 1938), that this spelling must be regarded as a usage desirable to follow.—*Ed.*

TABLE GIVING DETAILS OF THE RESETTLEMENT OF VARIOUS TRIBES IN TANGANYIKA TERRITORY

Year	Area	Tribe	Number of taxpayers moved	Total population moved	Move took	Average distance moved	Tracks cut	Total mileage run by lorries	Means of transport	Petrol consumption	Total cost	Cost per tax-payer	Cost per person	Remarks
					Days	*Miles*	*Miles*	*Miles*				*Sh.*	*Sh.*	
1933	Kibondo-Kasulu	Waha ..	11,320	37,300 approx.	60	—	—	—	Co-operative head transport	—	No special allocation	—	—	*See (1).*
1936	Urambo	Wanyamwezi	1,251	3,253	51	20	—	22,149	Road train and 6 Govt. lorries	—	£491 3 74	7 85	3/02	*See (2).*
1937	Uyowa-Bugomba Bweru	Wanyamwezi Wasumbwa Waha	1,500 150	5,000 approx.	75	30	300	33,393	Road train and 10 Govt. lorries Porters	—	£1,365	16,54	5 46	
1940	Itaranganya-Mpunze	Wasumbwa	461	1,659	46	12	20	12,624	4 Govt. lorries and 2 hired lorries for few days.	9 m.p.g.	£341 8 78	14/81	4/–	*See (3).*
1941	Mahenge	Wangindo-Wapogoro	1,680	7,000 approx.	71	50	92	24,000	Average 6 hired lorries (1 Govt. part-time).	8 m.p.g.	£2,283	27/18	6/57	*See (4).*
1941	Madaba	Wangindo-Wapogoro	166	846	33	38	111	4,965	4 hired lorries, 1 Govt. lorry.	6·7 m.p.g.	£1,200	144 57	28/37	*See (5).*
1942	Ruaha	Wangindo-Wapogoro	1,440	5,760 approx.	14	20	30	8,000	2 hired, 1 Govt. lorry and head porterage. Distance moved by lorry max. 28 miles, by porters 6-80 miles.	—	*£1,779	24/70 *4/17	6/17	*See (6).*

(*1*) Loads averaged 40-50 per family; many had 80-100 loads, few had less than 20 loads.

(*2*) Six lorries moved less than half population at cost of £300; road train moved remainder at cost of £100. Plenty of food—one trip three houses filled road train.

(*3*) 440 lorry loads of food—few loads less than one lorry; Chief had three 2-ton loads; a few families had 4-5 tons each.

(*4*) Estimated 300 kg. per family.

(*5*) 66 lorry loads of food moved; approximately 250 kg. of grain and beans per family.

(*6*) 300 old people and 22 tons of food and household effects moved by lorry. 760 taxpayers and effects moved by lorry, remainder by porters. Average load of food per family was 320 kg.

*The figure of £1,779 includes cost of drainage of swamps, purchase of seed, cultivation of Government farm, building of burnt-brick hospital. The cost of the *actual move* was Sh. 4/17 per family.

be raised in these settlements; and if they were to be made permanent, then improved methods of agriculture were essential to maintain soil fertility indefinitely. This was realized by Maclean (1930), who attempted to make a start with a system of crop rotation.

But by the very nature of the disease the people at risk are the most backward natives in the Territory, those who live at a bare subsistence level, who are not interested in or affected by higher economic standards, and who have never had stock or have forgotten what it means to have them. In the earlier years it was found impossible to attempt to improve agricultural methods by rotation of crops: it was tried in a few settlements, and not only failed but produced discontent and unrest, with a tendency for the settlers to run away into the bush, where it was difficult to find them again.

The first agricultural efforts were, therefore, concentrated on increasing the acreage under food crop, so that at all times of the year the people would have ample food, and not suffer those periods of short rations or actual starvation to which they had previously been exposed. If they were able to produce a surplus of food for sale, so much the better. The mere fact of a large number of them living together in one settlement automatically produced a local market, at which the people could barter their surplus food; and this in itself tended to produce a more varied and better diet.

The next step was the introduction of food crops to which the people were not accustomed, such as rice in Tabora District, groundnuts in Kigoma District, sim-sim in both, and pigeon pea in Kahama District. These newer crops might be used solely as economic cash crops, or they might be adopted into the dietary and only the surplus be sold.

The introduction of goats, as a rule, did not have to be pressed. Cattle, however, were different. In some areas, such as northern Tabora and Uha, some of the people had cattle "farmed out" with friends or relations in Nzega or Urundi, while in a few other areas some of the older people still remembered being cattle-owners, before they lost their herds from trypanosomiasis. In certain of the settlements, Government-owned cattle were introduced from the sixth year onwards. They were usually herded in the centre of the area, near the dispensary, and were slided and treated by the hospital dresser as required. The demonstration that cattle could be kept was usually followed, after a few years delay, by the introduction of native-owned herds, which are gradually being built up; but without such a demonstration by the Government, no native will risk the loss of his capital by introducing cattle on his own. The cattle were introduced by the Medical Department, primarily as a demonstration and in the hope that by the use of the milk and meat available the diet of the people would be gradually improved.

This is the position to-day in those sleeping sickness settlements which have been in existence from six to seventeen years. What of the future? As there are over 33,300 taxpayers involved, in some 28 settlements in the Western Province alone, the problem is a major one.

In those settlements which have been enlarged to the full 16 acres per family, and which have been thoroughly cleared, "shifting cultivation" within the area has taken place, and has in fact been encouraged, so that no land is used continuously to the point of exhaustion. But now that the limit of expansion is being approached, what agricultural methods can be adopted to preserve the soil fertility indefinitely? And as the ordinary cash crops cannot stand the transport to railhead, which may be anything from 60 to 200 miles away, what means are there for giving the people the cash in hand for their economic progress? The usual one of the men leaving the settlement to go and work for wages does the settlement and the people no good; while bees-wax collecting, though lucrative, and fishing are not within everybody's abilities and are both dangerous occupations as men, and often women and children, spend long periods in the tsetse bush.

There have been several reports of natives occupying the same holdings of *miombo* soils for periods up to 25 years, without any marked decrease in grain yields. And in Nyonga the farmers are emphatic that a two- to three-year grass fallow restores fertility largely to its original level (personal communication from Mr. C. Macquarie, Sleeping Sickness Surveyor). The problem of maintaining soil fertility is not acute at present; but it must be faced and dealt with in the near future, as it is not desirable that all these sleeping sickness settlements should be moved every 20–25 years or so. They have been made under Government supervision and compulsion, and it is up to the departments most concerned to devise a system by which the fertility of the soil can be maintained, in-

definitely, by the native farmers. And as the natural level of fertility of *miombo* soils is low, the further problem arises of trying to increase the fertility of the soil beyond a bare maintenance level, if the people are really to achieve economic progress.

With this object in view, the advice of Mr. R. R. Staples, Botanist, of the Veterinary Department, was obtained. After visiting a large number of the sleeping sickness settlements in the Western Province, he was of the opinion that the introduction of cattle, on a large scale, would solve both problems. Allowing $3\frac{1}{2}$ acres of grazing per beast, he estimated that the larger settlements could carry 2,000–3,000 head of stock (i.e. 5–6 per family). With propaganda to encourage the people to bed-down their cattle in covered sheds, sufficient high-grade manure would be obtained for them to manure their fields every fourth year, as recommended by Rounce, King and Thornton (1942). The milk available, and the slaughter of bullocks, would provide essential supplements to the diet. When 2,000 or more head of stock were present in any settlement, it would be possible to establish a local clarified butter factory; and clarified butter, hides and slaughter stock on the hoof are *the* "cash crops" which are able to stand the long transport to railhead and other more populated areas.

This scheme depends for its success upon two assumptions:

(1) That the grazing available in those settlements made in *miombo* country will maintain a beast to every $3\frac{1}{2}$ acres. And maintain them not merely at starvation level, but in good milking condition and allow for full growth.

(2) That the application of three tons of manure per acre every fourth year will maintain soil fertility, and allow of the permanent cultivation of a holding.

Parnell (1939), discussing native agriculture in *miombo* country, stated that: "A more important point is the determination of what quantity of manure a settler on such poor land can reasonably be expected to produce, how this amount can best be used and whether such use will make permanent cultivation profitable". It is not certain whether the answers to these three questions are yet available.

Provided that the two assumptions stated above are correct, then the solution of the permanent occupation of the sleeping sickness settlements has been found, and there remain only the details of the finance, staff and propaganda to be worked out and applied over a long period of years.

From every point of view the success of the settlements is desirable. They were made as a preventive to disease, and have proved their worth; they have brought educational and medical facilities to the people which could not otherwise have been provided; and they have already allowed the people to progress some little way economically. With better agriculture, more crops and therefore more money, it will then be possible to start propaganda for better housing, better hygiene and better health in the fullest sense of the word.

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My plea is that in preparing for a new world order, it is necessary to have more accurate knowledge of the material resources of the world, and particularly the sources of energy, and to plan on the basis of that knowledge. It is no use to lay down a power scheme here and a land reclamation scheme there without reference to the general world layout in relation to food and to fuel. There should be in each country a body that gathers the necessary statistics as to fuel and agricultural products, and real importance afforded those bodies such as the World Power Conference, and some reconstituted International Institute of Agriculture, so that true information may be obtained from the various countries which can then be collated and made available through an authoritative body to the statesmen of the world. The object would be to prevent the repercussion on general economy which the blind sway of vested and political interests has produced in the past.

Prof. A. C. Egerton, Sec. R.S., at the meeting of the British Association, September, 1941.

PLANTING TREES IN FRESH-WATER SWAMPS

By Ivan R. Dale, Assistant Conservator of Forests, Uganda

Fresh-water swamp planting is usually undertaken as an anti-malarial measure in townships, or as a means of supplying fuel and poles to densely populated districts. Owing to the high costs of establishment all aspects need careful consideration. In the closely farmed parts of the Eastern Province of Uganda it has been found politic to plant up swamps in areas remote from forest reserves, as such planting results in the least disturbance in the economic life of the surrounding inhabitants. These plantations supply large-sized poles for African house-building, and fuel to such consumers as cotton ginneries, brickyards and schools, which otherwise clear the already sparse natural bush. In townships it is now realized that in spite of possible small-scale breeding of mosquito larvæ and the shelter given by the trees to some adult mosquitoes, tree plantations are cheaper, and in many cases more efficient, than drainage systems in keeping mosquitoes in check. Efficient drainage systems have usually to be complex and the drains cemented. It is not the high initial costs which have proved disheartening to the health authorities: it is the heavy annual expenditure on upkeep, coupled in some areas (more especially those with a clayey soil) with their inability to remove the water quickly enough.

In agricultural areas one often has some choice of the area to be planted. Where possible I choose swampy stream valleys, which look to be capable of easy drainage and, by the nature of the flora, of yielding a large volume of fuel quickly. As 50 acres is about the maximum area of new swamp planting that an African ranger can manage with the minimum of supervision one naturally selects swamps of this size, or those capable of easy extension at this rate of planting. In townships one has to plant up the areas selected by the health or township authorities, and although the outturn from such plantations may be extraordinarily useful for supplying the needs of the townsfolk and may bring in a handsome revenue, one can, if the plantations be poor, always console oneself with the fact that the essential purpose of the trees is to dry up the soil.

Considerable caution should be exercised before planting up lakesides. One should not plant below the highest known water level, and even then plantations may be ruined by abnormal conditions. The blockage of the Nile some years ago caused Lake Kioga to rise to unprecedented levels. In lakeside towns, instead of planting the lake edge it is better to revet the bank as has been done at Kisumu and Jinja.

Ditching depends on the nature of the swamp. The digging of the main drain or drains through the lowest and wettest parts must precede any other work. If much seepage from the sides occurs, it is advisable to dig contour drains round the edge of the swamp, these draining into the main ditches at intervals. The complexity of the secondary drainage depends largely on the amount of standing water during the time of planting. No young trees of suitable fuel species will stand immersion for more than about a fortnight, so the rule is drain where the water stands; but the fewer the drains the better I am pleased. Drains are always liable to be choked with litter and to form small pools at their bottoms, and are also troublesome when the plantations are exploited. In some areas, e.g. Soroti, the top layer is underlain by a pan or somewhat impenetrable layer of soil, which is underlain again by an easily erodable stratum. Here it is advisable when making secondary drains not to break through to the subsoil as the consequent gullying results in future trouble to all concerned. In many older plantations, where the soil has contained a lot of humus, the water in the main drains, owing to the drying and consequent shrinkage of the land, flows well above their immediate surroundings. This trouble can usually be mitigated by deepening the ditch.

In "wet and dry" swamps, e.g. Kitale, and in some seepage areas it is possible to plough. This should be done as early as possible before the planting season. Where ploughing is not feasible the vegetation should be burnt off. In very wet swamps the next stage is to stake out and prepare mounds for planting. In areas with a great deal of humus, e.g. papyrus swamps, it is usual to remove the living rhizomes from the mound, though it may be necessary to place some round the edge to give mechanical strength to it. Also it is advisable whenever possible (usually only possible near the edges of papyrus swamps) to mix mineral soil with the swamp mud, as the young plants in the dry season are liable to suffer from physiological drought. In less wet swamps whenever possible it is best to hoe the whole area before preparing planting mounds. When this cannot be done the hoeing should be done as soon as possible after planting. If in a township water stands round the planting mounds

it is usually possible to soak the water up with sods, or to throw grass leaves on to the water, the products of their decay being inimical to mosquito larvæ. Every effort must be made to get the plantations established within two years from planting by constant hoeing, weeding and beating up. Otherwise in most swamps the lush growth of grass and other herbage may cause trouble for many years.

For all the common species I prefer 8 ft. by 8 ft. planting espacement.

At altitudes where termites are of little menace, fast-growing gums are the obvious species to plant. At the prevailing altitudes of the Eastern Province of Uganda, 3,500 to 4,000 ft., Eucalypts are limited to the wettest areas, where the termitaries cannot exist. For many years *Eucalyptus robusta,* the Swamp Gum, was considered to be the best species, but recently *Eucalyptus saligna* (in East Africa, probably a mixture of *E. saligna* and *E. grandis* or possibly a hybrid) has come much into favour in Uganda. Owing to its faster and bigger growth I would plant *E. saligna* and reserve *E. robusta* for places which are liable to long periods of flooding. At Kitale some years ago, when the plantations were young, *E. robusta* was preferred in the wettest areas, with *E. globulus* (which does not thrive below 5,000 ft.) second, and *E. saligna* third. At one time in Uganda a Red Gum, which is probably a form of *E. tereticornis* or a hybrid between that species and *E. rostrata,* was much favoured. It has the advantage of being able to stand up to droughts on poor soils as well as to wet conditions, but owing to its paucity of foliage it does not suppress the grass well. Also it tends to be a crooked grower, and a small volume producer.

On seepage areas in Uganda, where termites may be troublesome, the only suitable species discovered is *Cassia siamea.* Though I prefer planting this species with seed sown at stake, it is possible that stump planting is more advantageous in swampy conditions. In some areas near townships in Uganda one finds patches of almost sterile sand, where even *Cassia siamea* finds difficulty in growing. Mangoes will grow therein, but are not looked upon with favour by the health authorities. Possibilities are the Tamarind and *Balanites aegyptiaca,* but the growth of these is slow at the best of times.

Cedrela toona may be of use, except in the wettest parts of swamps. In spite of one's efforts most swamp plantations produce a fair hay crop. To minimize the fire danger a belt of *Cassia siamea,* say six rows, should be planted round plantations below 5,000 ft. Mangoes are efficient, but slow to establish. Above 5,000 ft. Black Wattle, and at higher elevations *Acacia melanoxylon,* are efficient killers of grass.

The commonest injury is wind blow. The tendency to surface rooting and, in many swamps, the soft nature of the soil, often result in falls in high winds. These are commonest in the wet season. The stem of the tree should be removed early, in the hope that the stump will coppice. Root rot will often remove odd trees in young plantations. A more disturbing form of rot has been observed at the collar of half-grown *Eucalyptus robusta* in plantations which suffered from numerous floods in the very wet season this year.

When a plantation is felled the water-table rises (owing to the reduction in transpiration of water from the leaves), and if this coincides with a wet season the stumps may be drowned. This occurred extensively in the Tororo plantations in 1941 and 1942. So if possible the plantations should be felled during the dry season.

Owing to the different nature of swamps figures of yields are of little use. Some of the earliest Uganda plantations took some years to establish. A mean annual increment of 650 cu. ft. stacked has been recorded for *E. saligna,* and I have seen trees growing at 20 ft. a year. In papyrus swamps the fast initial growth of *E. robusta* may not be maintained. The mean annual increment per acre varies from 300 cu. ft. stacked in poorish papyrus swamps to about 500 cu. ft. on better soils. If one can get 300 cu. ft. from *Cassia* one is lucky. This species, usually being relegated to the poor seepage areas, often with underlying murrum, may give very little return.

The cost of establishment varies with the site, and with the knowledgeability of the local labour. On better sites plantations may be established for £8 to £12 an acre. Near Kampala, where a large-scale planting of papyrus swamp was successfully undertaken, the cost was £9 7s. per acre for the first block up to the time of felling at 10 years old.

The financial return depends on demand and on the royalty. If, as in Kenya, the royalty is a matter of tendering, good returns are probable in towns. In Uganda, where the policy of the Government is to provide cheap fuel (the royalty is approximately Sh. 4 for 100 cu. ft.), one has to wait two rotations at least before a profit is realized. In any case, in townships it must not be forgotten that the main purpose of swamp plantations is mosquito control.

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SOME UGANDA VEGETABLES
PART I

By J. W. Purseglove, B.Sc., A.I.C.T.A., Agricultural Officer, Uganda Protectorate

There is at present a marked shortage of vegetables in East Africa caused by the large increase in European population, the prolonged drought and the difficulty of importing European vegetable seeds. Greater use could be made of native spinaches and pot-herbs, many of which occur as common weeds and provide a palatable addition to the European menu. Even in normal times the maintenance of a steady supply of fresh green vegetables is often a difficult problem, especially when on safari.

The native pot-herbs most favoured by Europeans are *Amaranthus* spp., *Basella alba* and *Solanum nodiflorum*. They should be cooked in the same way as ordinary spinach—washed thoroughly and picked over, the coarse stalks and extraneous matter removed, and boiled in a small quantity of hot water, which is strained off at once after cooking the vegetables. They should be put through a sieve and served with a little melted butter or oil. Alternatively, they may be steamed. In addition to the above species, many of the other vegetables listed are worthy of trial by Europeans, but it should be remembered that boiling is essential in the case of those pot-herbs which contain poisonous or acid substances such as cassava or *Colocasia* leaves.

The normal native custom is to make the pot-herbs into a sauce by boiling them in water to which salt and some fat, either butter or sim-sim oil, is added. The staple food, which may be plantains, finger millet or sorghum, according to locality, is cooked separately and is usually served as a thick mush, lumps of which are dipped into the sauce before eating. Sweet potatoes are eaten in the same way, or they may be roasted and dipped into the sauce.

Native pot-herbs supply valuable amounts of calcium, iron, phosphorus and vitamins, notably vitamins A and C. Analysis of *Amaranthus gangetica*, which is closely allied to the Uganda species of *Amaranthus*, by the Nutrition Research Laboratory, Coonoor (1939) gave moisture 85.8 per cent, protein 4.9 per cent, fat 0.5 per cent, carbohydrate 5.7 per cent, calcium 0.5 per cent, phosphorus 0.1 per cent, iron 21.4 mgs. per cent, carotene (vit. A) 2,500 to 11,000, vitamin B^1 10, and vitamin C 173. The figures for the vitamins are given in international units per 100 gms.

Native diet on the whole is very unbalanced, especially among agricultural tribes with few or no cattle and where the bulky, starchy food of the staple crop forms the major portion of the food eaten. Dietary taboos play an important part in the quantity and variety of green vegetables eaten and native education on this point is urgently required. In some tribes there is a marked disinclination to eat green vegetables except in times of food shortage. It is often found that the women have a more varied and better balanced diet than the men. Loewenthal (1940) in his survey of diet and nutritional health at Gihoro in Kigezi District has shown that whilst the staple foods are consumed equally by both sexes, the pot-herbs are eaten principally by the women and girls, while the men and boys suffer more marked vitamin A deficiency. Thus, of the people examined, 25 per cent of the males were suffering from phrynoderma, compared with only 9 per cent of the females, of whom only one was an adult. Worthington (1938) states that African women appear to have fewer intestinal parasitic worms than the men and that this may probably be attributed to their more varied diet.

Calcium and vitamin deficiencies are contributory causes of tropical ulcer and dental caries, and green vegetables, which are often the main source of these food constituents in native diet, consequently play a large part in the prevention of these diseases. Specific deficiencies result in a general lowering of vitality and of resistance to disease. Vegetable relishes and pot-herbs, therefore, are of vital importance in native diet.

A striking case of the dietetic value of a customary native practice from Nigeria is quoted by Worthington (1938). Baobab leaves, which are particularly rich in calcium, are used in soup making; the leaves are shade-dried, with the result that the vitamins are not destroyed. This is also done in parts of East Africa. Raymond (1940) points out that green leaves should not contain much oxalic acid if they are to be successfully utilized as a source of calcium.

The Culwicks (1941) state that vegetable protein can only be used efficiently by the body if the sources are varied. The importance of the inclusion in native diet of different pot-herbs in addition to leguminous seeds thus becomes apparent. More attention could be given to the maintenance of a supply of green vegetables during the dry season and to the

drying and storage of such vegetables as already practised by some tribes.

There is considerable danger in changing the staple native food, particularly to white maize or rice, unless compensating changes, including an increase in green vegetables, is made in the rest of the diet.

Listed below are the commoner pot-herbs and plants with edible roots and seeds used as vegetables by Uganda natives. Some are cultivated; others occur wild. They may form part of the natives' normal diet, but some are eaten only in times of food shortage. The list is not exhaustive; many edible fruits and fungi are not included in the list. Brief notes on the botanical characters of the lesser-known plants are given and it is hoped that these will assist in identification. In the case of those plants which have common European names, these are given before the vernacular names.

Grateful acknowledgment is made to Mr. A. S. Thomas, Senior Economic Botanist, Uganda, and Mr. P. J. Greenway, Systematic Botanist, Amani, for their helpful criticism.

Acalypha bipartita Muell. Arg. Euphorbiaceae.

Ayu (Acholi); *Egoza* (Lunyoro); *Jerengesa* (Luganda); *Omugesha* (Lunyankole).

A shrub of the forest edge with small, alternate, slightly hairy leaves used as a pot-herb by many Uganda tribes. Baganda of the *Ngabe* clan must not eat them.

Allium ascolonicum. Linn. Amaryllidaceae.

"Shallot"; *Katungulu* (Luganda); *Katunguru* (Lunyoro).

The shallot, which is of Asiatic origin, is used extensively throughout Uganda for adding to many sauces and foods.

Amaranthus blitum Linn. Amaranthaceae.

Enyabutongo (Lukiga, Lunyankole); *Mboga* (Lunyoro); *Mboge* (Luganda).

A small much-branched glabrous annual, erect or decumbent, with axillary inflorescences of small white chaffy flowers. A common pot-herb throughout tropical Africa, occurring as a weed of cultivation and in a state of semi-cultivation near homesteads.

Amaranthus caudatus Linn. Amaranthaceae.

Bakansigalimu (Lunyoro); *Dodo* (Luganda); *Kyabora* (Lunyoro); *Obuga* (Acholi); *Omuriri* (Lukiga, Lunyankole).

An erect herb up to 3 ft. in height with numerous spikes of small chaffy yellowish flowers in dense terminal panicles. It is said to be introduced from Asia (Dalziel, 1937) and is usually cultivated. A form with red or purple leaves and inflorescences is grown for ornament and is known to Europeans by the name of "Love Lies Bleeding". The green form is one of the most extensively used pot-herbs throughout the tropics and makes an excellent substitute for European spinach. It is extremely easy to grow. In India and Peru it is sometimes cultivated for its seeds which are eaten as a cereal.

Amaranthus oleraceus Linn. Amaranthaceae.

Ebuga (Luganda); *Obuga* (Acholi); *Omubuiga, Omujuiga* (Lunyoro).

An erect herb, 1 to 2 ft. high, common in warm countries; some spikes axillary and others forming a dense cluster at the apex; membranous fruits; leaves larger than those of the above two species. It is usually cultivated.

A common pot-herd throughout Uganda. The young leaves and tender shoots make an excellent spinach for European use. It is regarded by the natives as a better pot-herb than *A. caudatus*, which is more hardy and is more widely used by the poorer people.

Amorphophallus schweinfurthii (Engl.) N.E.Br. Araceae.

A glabrous aroid with large much-divided leaves, commonly found in dry grasslands. The swollen rootstocks are eaten in times of food shortage.

Asclepias rhacodes N.E.Br. Asclepiadaceae.
Alamilam (Karamojong).

A herb with dull red flowers. Roots eaten in Karamoja (Thomas unpub.).

Asystasia gangetica T. Anders. Acanthaceae.
Kkoropot (Teso); *Temba* (Luganda).

A common much-branched perennial weed of tropical Africa and Asia; whitish flowers with faint reddish-purple markings. The leaves and young stems are used as a pot-herb by the Teso and Baganda. The latter consider that it will soften other vegetables if cooked with them. Its use as a pot-herb is widespread in East and West Africa.

Basella alba Linn. Basellaceae.

Enderema (Luganda, Lukiga, Lunyankole, Lunyoro); *Enyanzha* (Lunyaruanda).

A glabrous succulent climbing herb, native in high-rainfall areas throughout East Africa, with alternate cordate leaves, inflorescences of closely-packed small white flowers, and fruit enclosed in a persistent perianth. It is frequently grown in native plantain gardens, but it also occurs wild in the swamps. The young

shoots and leaves are extensively used as a native pot-herb and make an excellent substitute for European spinach.

B. cordifolia Lam. and *B. rubra* Linn., which have been considered as varieties of *B. alba* (Sampson, 1936), have been introduced into East Africa. They are easily grown and may be propagated by cuttings or seeds. As they will withstand dry weather and produce a constant supply of good "spinach" from a small area, they should be more widely grown than at present.

Bidens pilosa Linn. Compositae.

"Black Jack"; *Enyabarashana* (Lukiga, Lunyankole); *Kakurra* (Lunyoro); *Labika* (Acholi); *Sere* (Luganda).

This common composite with barbed seeds is one of the most troublesome weeds of the tropics. The young leaves are used as a potherb in some parts of Uganda,* as in West Africa. (Dalziel, 1937.)

Borassus aethiopicum Mart. Palmae.

"African Fan Palm"; *Ekitugo* (Lunyoro); *Itu* (Madi); *Ntungo* (Luganda); *Nyadokanet* (Karamojong); *Tugu* (Gang).

The fruit of the Borassus palm is an important article of diet among Nilotic tribes and is usually eaten raw. The Madi plant the fruit, and the germinating radicle, forced by earthing the nuts, is cooked as a vegetable. At a later stage the pale swollen hydrocotyl is also used as food.

Brachystelma sp. aff. B. *johstonii* N.E.Br. Asclepiadaceae.

Adodoi (Karamojong).

A herb with tailed corolla-lobes. Thomas (unpub.) has recorded that the root is eaten in Karamoja.

Burnatia enneandra Micheli. Alismataceae.

Nkorom (Karamojong).

A slender aquatic herb up to 4 ft. high with small white flowers. Thomas (unpub.) has recorded that the rootstock is eaten in Karamoja in times of famine.

Cajanus cajan (Linn.) Millsp. Papilionaceae.

"Pigeon Pea"; *Enkolimbo* (Luganda); *Enkuku* (Lunyoro); *Entendeigwa* (Lunyankole); *Lapena* (Acholi); *Mpinamiti* (Luganda).

Pigeon pea, one of the few food crops indigenous to Africa is grown extensively by the Nilotic tribes of northern Uganda, especially the Lango. As with most pulses, the pea is usually eaten after drying, but the leaves and immature seeds are sometimes eaten as vegetables. The young seeds make a good European vegetable, cooked and eaten in the same way as green peas.

Canna bidentata Bert. Cannaceae.

Ekinyagashana (Lunyankole); *Ilanga,* pl. *Amalanga* (Luganda); *Iranga,* pl. *Amaranga* (Lunyoro); *Oburagoi* (Lukiga).

The wild Canna; a perennial herb with red flowers; common in plantain gardens and moist places. The rhizomes, which are rich in starch, are eaten in times of scarcity in many parts of Uganda.

Capsicum annuum Linn. Solanaceae.

"Red Pepper"; "Chillies"; *Kamulali* (Luganda, Lunyoro); *Kamulara* (Acholi).

The fruit is a pungent condiment, rich in vitamin C, and is extensively used by Uganda natives for adding to sauces and for seasoning other foods. The leaves are also used. The plant is indigenous to tropical America.

Capsicum frutescens Linn. Solanaceae.

"Bird Pepper"; *Kamulali* (Luganda, Lunyoro).

The fruit, which is more pungent than that of *C. annuum*, and the leaves are used in the same manner as the above. It is native of tropical America and has become naturalized in some parts of Uganda.

Cleome viscosa Linn. Capparidaceae.

Kashoyeshaiza (Lunyankole).

An erect herbaceous weed, 1 to 2 ft. high, with alternate trifoliate leaves and small yellowish flowers. It is used as a pot-herb in parts of Uganda in the same way as *Gynandropsis gynandra,* a plant which it closely resembles.

Coleus esculentus (N.E.Br.) G. Tay. Labiatae.

Enumbu (Luganda, Lunyoro).

An erect perennial about 2 ft. high with short whitish hairs on the square stem and the small leaves. It has yellow flowers which are rarely seen. Cylindrical finger-like branched tubers up to 4 in. long and ¾ in. in diameter are borne clustered at the base of the stem.

The plant is cultivated in parts of Uganda for the tubers, which are scraped and cooked before eating. Thomas (1943) considers that it is of small importance in Uganda at the present time as it gives small yields and is not very palatable, but it can be grown on poor soils. It is, however, highly esteemed by the Banyoro. Dalziel (1937) states that Europeans in West Africa use the tubers as a farinaceous vegetable and that they can be pickled.

* And elsewhere in East Africa.—*P.J.G.*

C. dysentericus Baker, which is almost glabrous and has blue flowers, is also cultivated in Uganda for its edible tubers. Both species are indigenous to Africa.

Colocasia antiquorum Schott. Araceae.

Ebihuna (Lunyoro); *Kiyatamuno* (Acholi); *Timpa*—leaf (Luganda); *Yuni,* pl. *Mayuni*—tuber (Luganda).

A herb with large peltate cordate leaves, a native of tropical Asia and Malaya, which has been cultivated in Egypt and India from remote antiquity (Dalziel, 1937). It is grown by Uganda natives, usually in the plantain gardens. The starchy tubers, which are used like potatoes, contain an acid substance which is removed by cooking or repeated washing. The young leaves, after removal of the larger veins, are used as a pot-herb by most Uganda tribes, who often dry and store them until required. The petioles are also edible, after taking off the cuticle. The acridity of the leaves and petioles is removed in boiling, and Dalziel (1937) recommends that soda be used in cooking them.

Corchorus olitorius Linn. Tiliaceae.
"Jute"; *Eeteke nyamusiri* (Lunyoro).

A glabrous herb with small yellow flowers. In this and the two species given below, two of the leaf serrations are prolonged into hair-like appendages on each side of the leaf stalk. It is cultivated in Uganda for the young leaves, which are used as a mucilaginous pot-herb and make a good spinach substitute for Europeans. The stems yield a bast fibre.

Two other species (*Eteke nyakarabyo*: Lunyoro) are also used as pot-herbs in Uganda, viz. *C. trilocularis* Linn., which grows in forests, and *C. tridens* Linn., which is a widespread weed of cultivation.

Cucurbita maxima Duchesne and *C. pepo* Linn. Cucurbitaceae.

Leaf—*Ekisunsa* (Lunyoro); *Esunsa* (Luganda); *Orutetere* (Lukiga, Lunyankole); *Pot Okono* (Acholi). Fruit—*Ekihazi* (Lukiga, Lunyankole); *Ensuju* (Luganda); *Okono* (Acholi); *Omwongo* (Lunyoro).

Coarse, trailing herbs with harsh foliage and stems and large yellow flowers. They are cultivated throughout the tropics. *C. maxima* is the pumpkin and *C. pepo* the vegetable marrow. The pulp of the young and mature fruits is eaten as a vegetable, and the young leaves, after removing the veins, as a pot-herb. Pumpkin flowers and seeds are also eaten. Both species are easily cultivated and give quick and heavy returns on good soils and have the advantage that the mature fruits, if stored in a dry and airy place, will keep for several months after harvesting. They should be planted so that the fruits may ripen in dry weather, otherwise they may rot.

Dioscorea alata Linn. Dioscoreaceae.

"Water or Winged Yam"; *Kisebe, Nandigoya* (Luganda); *Ndaigo* (Lunyoro).

A cultivated yam of Asiatic origin with quadrangular four-winged stems which never bear prickles. Yams are fairly extensively cultivated in Buganda and Bugishu, but they do not form an important article of diet among many of the Uganda tribes.

Dioscorea bulbifera Linn. Dioscoreaceae.

"Potato Yam"; *Isome,* pl. *Amasome* (Lunyoro); *Kobe,* pl. *Amasome* (Luganda).

A climber with alternate cordate leaves, bearing axillary angular bulbils, which grow to 6 in. in diameter at maturity. It is cultivated in parts of Uganda, usually in the plantain gardens. The bulbils are scraped and boiled before eating.

Dioscorea mildbraedii Kunth. Dioscoreaceae.

Ndagu (Luganda); *Orurali,* pl. *Ndali* (Lunyoro).

A twining yam with opposite glabrous leaves, prickles on the stem, and small round sessile flowers. Occurs wild in Uganda, but is sometimes planted. The tubers may be cooked and eaten without danger.

Dioscorea praehensilis Benth. Dioscoreaceae.

A wild yam with edible tubers, very similar to *D. mildbraedii*, collected and eaten in times of food shortage.

Dioscorea rotundata Poir. Dioscoreaceae.

Varieties—*Barugu, Bikonga, Kyatutumula* (Luganda, Lunyoro); *Obato, Mwodo* (Acholi).

The most commonly cultivated species of yam in Uganda. The varieties named are glabrous and prickles are usually present. *Kyatutumula* has larger tubers than the other named varieties, and those of *Bikonga* are very hard. These yams are a useful substitute for the European potato.

(*To be continued*)

THE ECONOMICAL CONSTRUCTION OF A CATTLE DIP*

By R. J. Mitchell, Kiminini, Trans-Nzoia, Kenya Colony

Mixed farming has been frequently discussed and strongly advocated by both agricultural officers of the Colony and stock enthusiasts amongst the settler community. Very little, however, has been done to bridge the financial difficulties of what is commonly called a "change-over". In fact, the standards originally established by Government for dip construction entail an expenditure prohibitive to the average farmer. How such expenditure may be considerably reduced without impairing either the efficiency or the durability of the dip, this article will describe. It may be well to mention that the details of cost and construction apply to a dip *built in* 1934, *when costs were approximately half those ruling under war conditions to-day.*

The dimensions are those published by Messrs. Cooper and Nephews, South Africa, which give a 50 ft. water line. To this has been added 1,100 sq. ft. of concrete, walled-in draining pen. There are no posts and rails, since brick, iron and concrete were alone used. The total all-in cost amounts to £49. By eliminating the walled entrance crush and the dripping yard, neither of which are usual adjuncts to a dip, and by substituting thatch for iron on the roof, the cost of the dip, including the usual type of entrance and exit races, might have been reduced to a total of about £36. Where suitable building stone is more cheaply procurable than brick, a corresponding reduction in the costs should result by using it. The Kenya Cattle Cleansing Ordinance stipulates a minimum length of 40 ft. water-line; here also a further reduction in costs might be made by adopting the shorter or 40 ft. dip.

All bricks used were made on the farm. Stone and sand were also procured on the farm, though not readily. Cement and iron carried the "railhead" cost. Water in abundance was at hand—a point always to be borne in mind when selecting a site. No so-called skilled labour was used; the work was carried out by the ordinary farm hands, one of the more intelligent doing the brick-laying and cement plastering and pointing. Supervision was, of course, necessary to bring the standard of work up to that of a good native *fundi*.

A site was chosen adjacent to the farmyard, where shelter was obtained for storing materials. A dip, moreover, like a vegetable garden, gets better attention when near the homestead. The ground had a slope of 1 in 40, and the subsoil was of suitable texture. The excavation was made with an allowance for 18 in. side and end walls, so that the entrance was towards the higher ground. The dip, when finished, being 2 ft. wide at the bottom, gradually sloping out to 4 ft. at the 5 ft. level and retaining that width to the top, gave on completion of excavations a width of 5 ft. at the bottom, a length of 27 ft. in the deep, with an exit slope well graded to the desired length and height, leaving a bottom end width of 5 ft., increasing gradually to 7 ft. at the top end. Heavy hammers were used to consolidate the floor surface, including the exit slope.

The wall foundations were now laid, 2 ft. 8 in. apart in the deep portion. This allowed for the 2 ft. width of the dip at bottom, together with 4 in. for the concrete facings on each side, care being taken to observe the necessary splay of the walls up the exit slope. These foundations were of concrete, a mixture of cement, sand, and broken stone in the proportion of 1, 3 and 6 respectively. It will be understood that all concrete work was well tamped down to ensure consolidation and the filling of voids. Only river sand was used. It was carefully washed but not screened, except for plaster work. The stone was broken to a grade ranging from an inch to that of coarse sand, and subsequently washed.

On the concrete foundations 14 in. brick walls were built, headers only showing towards the face or dip side; one row of stretchers at the back and all spaces occurring between the wall and the bank were solidly packed with brick broken to suit. The mortar was of the ordinary brick soil *donga* type. It was well worked and only sufficient was applied to bed the brick compactly after the manner of wood-glueing. To maintain the necessary slope of the walls, four lengths of 2 in. by 2 in. timber were stood in position, one at each corner of the deep section of the dip. Each pair was

* In response to requests from subscribers, the revised version of Mr. Mitchell's article in this *Journal*, Vol. 2, No. 6 (1938), has been prepared by him.

placed 2 ft. 4 in. apart, inside measurement at the bottom, and 4 ft. apart, inside measurement, at the 5 ft. high level, the slope being equalized to both sides and the timbers so secured. The outside of these guides have the alignment for the face of the walls for the whole length of the dip. The entrance end wall was built perpendicular, not sloping. To give a more complete lay to the bricks up to the water level of the dip each was gently tapped with a hammer after being pressed into position by hand.

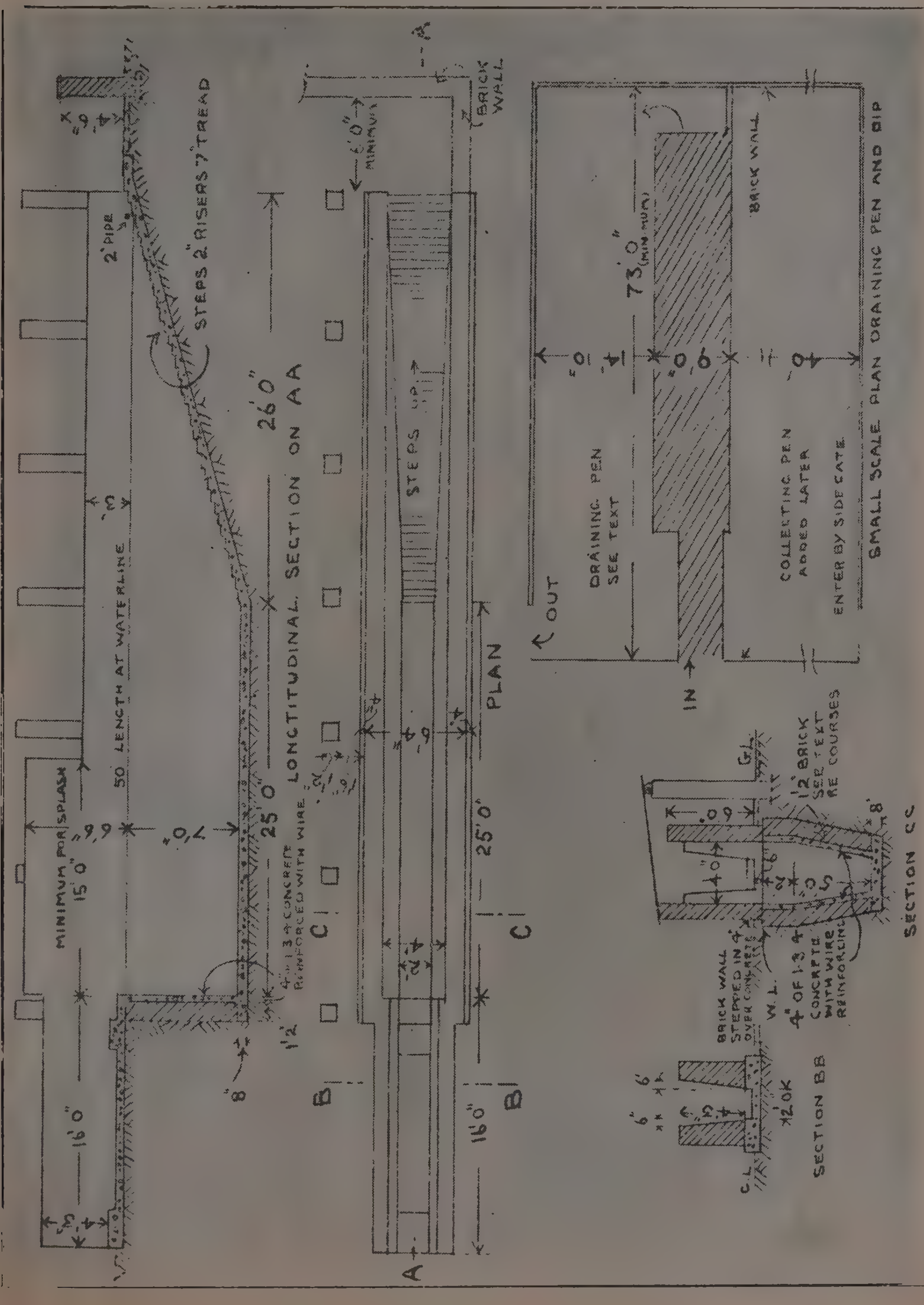
At the 5 ft. level wires were built in horizontally across the wall. These were bent over at one end to form hooks that protruded from the wall about one inch. These wires were placed about 4 ft. apart, and served to hold in position a strand of fencing wire which was passed through the hooks along both sides. The loose ends were secured at the top of the exit slope with a reasonable amount of tension. The walls were now carried up to a height 7 ft. 8 in. from the bottom, the last 2 ft. 8 in. being built perpendicularly, headers and stretchers in the usual way, and care being taken to pack well all spaces occurring between the wall and the bank.

The brickwork having now sufficiently advanced to enable the concreting to be carried out, the cleaning of the brickwork as for pointing was next attended to, and the whole work well washed down. The resultant accumulations of mud on the floor and slope were removed and the latter again beaten firm. The concrete was now laid, a 4 in. layer of 1, 3, and 6 mixture, filling the space between the concrete foundations to an approximate level with the latter.

Reinforcing followed, and consisted of heavy gauge barbed wire (about 2½ rolls). The cross strands were placed about 1 ft. apart, their ends passing upwards between the built-in strand of fencing wire and the walls, so adjusting the reinforcing to the angle of the wall at that point. The ends were then carried over the top of the wall and stapled to poles or battens laid on a level with its outer edge. The longitudinal wires for the bottom and slope were four in number and were carried up the entrance end and secured over the wall similarly to the cross strands. Both cross and longitudinal wires were now stapled down to the concrete floor at points of contact, care being taken to observe the necessary tension for all the wires and to have the stapling done before the concrete set too hard. Wires were spaced 6 in. apart, or thirteen in all, extending along the sides and round the entrance end. Binding wire was used to fasten these to the cross strands at points of contact.

The final coat of concrete, a depth of 4 in. of 1, 3, and 4 strength, was then laid on the floor and exit slope. To form the steps up the slope, 2 in. by 2 in. scantlings were cut to the desired lengths to mould the risers; this also provided for a suitable area of tread. Shuttering for the entrance end was made in the form of a wooden frame that could be built up 2 ft. at a time as the work of concreting proceeded. Sheets of roofing iron were used for shuttering the sides. These were stood on edge and adjusted so as to give a concrete facing of 3½ in. The staying was done by frames made to the size of the final internal measurements of the dip. A better and less extensive method of staying is, however, by laying rows of bricks across the dip at about 3½ to 4 ft. apart and placing a strip of 1 in. board between the brick and the iron. The bricks have to be built up 2 ft. at a time to accommodate each additional sheet of iron put in position as the work proceeds. Small cuttings of timber of a suitable size were used to preserve the 3½ in. spacing between the walls and the iron sheets. A suitable platform on which to prepare the concrete was made by concreting about 10 ft. square of the draining pen, the proper level and grade of which were, at this stage of the work, readily found. All the concrete for facing the dip walls was made of the 1, 3, and 4 proportions, and sufficiently liquid in consistency to find its way into the seams of the brickwork and the corrugations of the iron. This was assisted by spading and tapping the iron sheets gently with a hammer over the area that was being filled. The reinforcing wires were found to maintain a position approximating to the centre of the concrete facing without any attention being paid to this detail. To make a connexion between the interior of the dip and the sump, a piece of 2 in. iron piping with a plug stopper was concreted in at a suitable level near the exit end of the wall screening the draining pen from the dip.

The concrete had set sufficiently within twenty-four hours to admit of the removal of the shuttering without damage to the work; the iron sheets having been previously oiled to prevent the concrete adhering. To protect the work during plastering and subsequent seasoning, the iron sheets were laid over the top of the dip to form a temporary roofing.


LONGITUDINAL SECTION ON AA
PLAN
SECTION BB
SECTION CC
SMALL SCALE PLAN DRAINING PEN AND DIP
STEPS 2" RISERS 7" TREAD
2" PIPE
50' LENGTH AT WATERLINE
MINIMUM FOR SPLASH
4" of 1:3:4 CONCRETE REINFORCED WITH WIRE
BRICK WALL
STEPS UP
DRAINING PEN SEE TEXT
COLLECTING PEN ADDED LATER
ENTER BY SIDE GATE
OUT
IN
BRICK WALL STEPPED IN 4" OVER CONCRETE
4" OF 1:3:4 CONCRETE WITH WIRE REINFORCING
1½ BRICK SEE TEXT RE COURSES
73' 0" (MINIMUM)

Three parts of screened sand to one of cement were used for plastering. No pudlo was used in the first coat, which amounted to filling up the iron corrugation lines and all inequalities observed in the work. This coat was quickly followed by a pudlo coat for the final plastering, the surface being well smoothed over. Three parts pudlo to one hundred parts cement, with the same sand content as for the first coat of plaster, were found to give a sufficiently waterproof finish. The pudlo coat was applied to a thickness of $\frac{3}{8}$ in. as nearly as practicable, and a total of 10 lb. of pudlo was used. Surfaces were adequately soaked with water before plastering and the whole work sprayed twice daily for ten days before removing the temporary roofing. The reinforcing wires were now detached from the poles or battens to which they were stapled, and built into the walls; which were carried up to their respective levels. The one on the right looking down from the entrance end was sufficiently high to deal with the splash and at the same time to give adequate supervision. To prevent loss by splash the first 15 ft. should be built up to 6 ft. above water line; 3 ft. will do for remaining length. The wall on the left extended the whole length of the dip and to a height of $6\frac{1}{2}$ ft. above water level. It served the dual purpose of enclosing a portion of the dripping pen and giving a direct support to the roof on that side. On the right side the roof was supported on pillars built 18 in. clear of the wall, to admit of easy access to that side of the dip and sufficiently high to give the necessary head room. The resulting roof span was then covered with the iron sheets used for the casing (25 in all), using a single corrugation overlap. When the iron is sound this method may be safely adopted for all farm buildings.

The entrance race was constructed of brick walls, built to the dimensions of a cattle crush. Its length of 16 ft. joined the side walls of the dip with a doorway in a cattle shed, the latter serving as a collecting pen during the dipping operations as well as providing added enclosure for the dripping pen. The additional walls required to complete the enclosure of this area were built to a height of 4 ft. 6 in. and cement capped. Bricks, being more easy to come by than stone, were used as a foundation for the concrete floor of the pen. When a firm earthen floor has been secured, with a fall of 1 in 40, the bricks were laid with all-round spaces of about $1\frac{1}{4}$ in., into which the concrete was allowed to settle, especially its coarser elements, leaving the finer grouty ingredients covering the whole of the brick surfaces; the whole being consolidated by well beating down. This concrete was of a strength of 1, 3, and 6, overlayed by a coat of 1 cement to 4 of unscreened sand. Roughing and draining lines were impressed by beating down with a heavy hammer a length of 3 in. by 2 in. scantling at regular intervals. By this means a draining pen with an area of 1,100 sq. ft. was well laid, using only 22 pockets of cement. All exposed walls were capped with cement and brickwork, pointed with cement and plastered where necessary. To prevent a waste of all the dip water when emptying for cleaning, a temporary barrier may be erected at exit end of dip and the water pumped into the draining pen. When allowed to settle there for 24 hours most of it can be returned in a fairly clean condition. This is an economy that can best be achieved by the use of a good draining pen and more than justifies its initial cost.

When the dip was first filled with water a slight leakage was observed, due presumably to the floor being put down without the addition of pudlo. To remedy this a solution of cowdung and cement, three parts of the former to one of the latter, or one-third of a *debi* (4-gallon tin) of cement to a full *debi* of cowdung, was creamed into twelve gallons of water and spread along the dip. No further leakage was observed.

The seven years service that this dip has already given without the silghtest sign of flaw or wear occurring in the structure may be taken as proof of the adequacy of the materials used and methods applied.

(It is noted that the construction of this dip is light, and though the author has found results satisfactory over a period of years, it is wise to point out that probably under differing soil conditions it would not prove suitable. In certain volcanic and black cotton soils, for example, dips have been crushed by soil movement and expansion between dry and wet seasons. True, certain dips have been cut out of solid murrum and the side walls have stood for some years with plastering only, while the out steps and entrance have been protected by stone, but these must be considered as exceptions. For this reason it seems likely that in most cases much stronger construction would be advisable.—*The Editor.*)

TRIALS WITH BROMUS MARGINATUS ON THE KINANGOP, KENYA COLONY

By J. Etherington

We claim no shattering discovery or originality of thought in deliberately putting part of our arable land down to temporary pasture: it is already the standard practice in agriculturally older countries and probably in other districts of Kenya, but it is the first experiment on a fairly large scale on the Kinangop and therefore, perhaps, of general interest.

Until the Agricultural Officer, Rumuruti, suggested *Bromus marginatus*, a grass imported from Australia,* one had the choice of keeping one's land permanently under cultivation, letting it go back to weeds or putting it under Kikuyu grass (*Pennisetum clandestinum*).

Arable land in this area which has "gone back" is not pretty to look at and is almost useless as grazing while Kikuyu grass suffers, in the area under review, from a number of objections both as temporary ley or permanent pasture. As a temporary ley it is difficult to eradicate when the land is again brought under cultivation and as a pasture it is often destroyed by frost during the dry months when grazing is, in any case, scarce.

Our experimental plots of *Bromus* in the vegetable garden were encouraging—the grass was quick-growing, palatable and owing to its free-seeding habit spread naturally and in competition with the extremely tough local vegetation.

In September, 1940, we ploughed in ten acres of pyrethrum growing on medium-quality land which had been under cultivation for seven years—two three-year periods of pyrethrum with one season under oats for forage in between. Incidentally, in the second period under pyrethrum the yield of flowers was much lower than in the first.

In late November of the same year sunflowers were sown on the land. A small proportion of these, on the richer patches of the field, were cut for forage during the January and February dry weather, 1941, and the balance ploughed in for green manure when just coming into flower at the break of the rains. In March, 1941, the land was harrowed and the *Bromus* seed broadcast immediately at the rate of 15 lb. per acre.

We realize now that three mistakes were made; the sunflowers should have been trodden down before ploughing in, a month or two should have been allowed for them to rot and the sowing of the *Bromus* seed should have been at the rate of at least 25 lb. per acre. Regarding the latter the writer found that with the gate of the Cahoon sower fully open only 15 lb. of seed could be broadcast per acre and the flow of seed had to be assisted with the left hand.

Owing, presumably, to the moisture absorption of the rotting sunflowers there was a long interval after seeding before the grass was long enough to be grazed: in fact it was not until the second half of July, 1941, that we judged it sufficiently well established to put the cows in to graze.

Previous to this we had mowed once to enable the herbage on the poorer soil down the slope to catch up with the better growth on top of the ridge.

Although *Bromus marginatus* has a rather tufted habit of growth the stand was definitely too sparse owing to the light seeding. This condition, however, was mitigated somewhat by a good stand of indigenous white clover which arrived spontaneously and which, by the end of 1942, formed, with the *Bromus*, a complete sward.

At the first grazing 33 cows were put in the paddock daily from 9 a.m. to 1 p.m., the rest of the day being spent on the veldt. Their aggregate daily milk yield before starting the experiment was 65.7 gallons and after grazing on the *Bromus* for seven days this had risen to 77.7 gallons, the rise commencing after the third day. A parallel herd of 31 cows on the same farm, grazed and herded in the usual manner, dropped in the same period from 46 gallons to 39.3 gallons per day. Both herds were in large paddocks at night where the grazing was similar, and both received concentrates according to yield. The concentrate ration of the herd on the *Bromus* was not changed during the experiment. The natural grazing, as is usual on the Kinangop in July, was deteriorating, the weather cold and dry.

At the end of 14 days it was judged that the paddock was sufficiently closely grazed and the cattle were returned to their usual grazing grounds. The milk yield, which had increased

* Originally from the Pacific Coast of the U.S.A.

and then remained stable throughout the experiment, dropped in three days to the old level.

In November 35 cows were again put on the paddock for four or five hours a day; the total rise in yield was 13.3 gallons daily at which level it was maintained.

It may be of interest to note that on several occasions when part of the herd was on *Bromus* the other cattle were grazed on a field of apparently luxuriant Kikuyu grass but with no noticeable benefit.

Thinking the preceding results encouraging, we put another 16½ acres of poorish land, which had been under pyrethrum since 1936, under *Bromus* in the long rains of 1942.

In October milk yields were dropping severely owing to the dry weather and shortage of concentrates, so we decided to put all the cows in milk, totalling 81 head, into the two *Bromus* paddocks.

On 12th October the total milk yield was 119.9 gallons.

On 15th October it had dropped to 114.4 gallons.

On 15th October the cattle were put on the *Bromus*.

On 19th October the total milk yield had risen to 140.6 gallons which was maintained until the 22nd October when the grazing on the 16½ acres was finished. Thirty cows were kept on the old ten acres for another week and their yield was maintained but by the 26th October the yield of the whole herd had dropped back to 122 gallons.

Conclusions

Bromus marginatus grows well at 8,500 feet on moderate to good land provided the soil is well drained. It does not frost and continues to grow, though slowly, in the dry weather.

In my opinion an acre per milking cow would supply all the grazing necessary and probably some hay as well. I make no pretence at being an agricultural economist but in increased milk alone the profit per acre of *Bromus* appears to be about £2 per annum over and above the grass value of the ordinary veldt grazing. In addition there is the "hoof manure" put into the land by the cattle in paddocking. To obtain the full benefit of the manure (and of the grazing) paddocks should be subdivided and the cattle kept on each section night and day and in rotation. It would probably be a good thing for sheep to follow the cattle.

Here, in future, we intend to sow oats or wheat with the *Bromus* to nurse it up and provide a sward more quickly.

(*Received for publication on 27th February*, 1943)

NOTE BY SENIOR AGRICULTURAL OFFICER (PASTURE RESEARCH)

BROMUS MARGINATUS AS A TEMPORARY LEY AT HIGH ELEVATIONS

Despite Mr. Etherington's modest introduction, I think it can be said that his is one of the earliest attempts in Kenya to make practical use of the much-discussed and well-proved principle of temporary grass leys in rotation with arable crops. His results are most encouraging and should provide an incentive to other farmers to follow this line.

The comparison drawn between the returns derived from the *Bromus* paddocks and the surrounding natural pasture illustrates an important point, namely, that a pasture in its first year or two of establishment is markedly more productive than old grassland. This fact is now well known in Britain and it has been proved in a range of grass species in Kenya.

The experience gained on the Kinangop is the more valuable since it deals with the high-altitude areas where, by reason of low temperatures, the pasture species available for use in the greater part of the potential ley-farming country do not succeed. It appears that the trial has contributed both towards a solution of the problem as to the grass to use and towards an answer to the important question of a leguminous constituent of the ley. In this connexion it should be pointed out that *Bromus marginatus* is not suited to areas below 7,000 ft. elevation, and it requires a moderately good and well-distributed rainfall.

The stage has not yet been reached when the benefit of the ley and of the accumulated manure will be reaped in the subsequent arable crops, but it can be safely assumed that the result will further prove the value of the experiment. It remains to be seen how long the *Bromus* ley can be allowed to remain with advantage in this particular area, but according to experience elsewhere it should be ploughed up before marked degeneration of the sward has set in.—*D.C.E.*

NOTES ON AGRICULTURE IN ETHIOPIA
PART III

By Major F. de V. Joyce, M.C.

I know little about the subject of drug plants, but suggest that experiments be carried out with some at least of the following plants, and probably many others:—

Cinchona (for quinine salts).—At Jimma I saw in the Italian Government experimental farm the hardier type of quinine (*Cinchona succirubra*) growing well. It was six feet high in two years growth. *C. Ledgeriana*, which has a higher alkaloid content, was said to be in the nursery, but I could not find it as the weeds were four feet high.

Carraway Seed (*Carum Copticum*; Amhara HECC) for the extraction of thymol, of which there is a world shortage.[1]

Derris Root, which was in great demand by agricultural wholesale chemists before the war, at very good prices.[2]

Stramonium.—A universal weed in Africa, which produces some much-needed drug. British wholesale chemists were prepared to take unlimited quantities of the dried leaf a year or two ago.[3]

Khat (also spelt "Chat" or "Kat"; *Catha Edulis*).—Universally grown in the Harar Province and contains some narcotic principle which would be worth exploring.[4]

Areca nut, coriander, ginger (grows wild), nutmeg, pepper, etc.

It it has not already been done I suggest that the active principle of the Kosso tree (*Hagenia anthelmintica*) be explored[5] and that a shrub grown in the lower country and which, at Bonga, is known as "Inkoko", be identified and examined.[6] Where the Kosso does not grow the natives use the seed of this "Inkoko" for the same purpose—the monthly vermifuge—and declare it to be less severe and more effective.

I believe that much time has been given to the study of plants of this nature at the Amani Institute in Tanganyika, and I suggest that a fourth (and last) expert be procured to join the others (tea, rubber and cotton) in a two or three months tour of the same area.

Soil Conservation

As stated previously, the soil of Ethiopia is extremely permeable to water and visible erosion on ploughed land is rare. Somewhere in Tigré I saw a very heavy shower on a clean fallow and there was no run-off at all, and in a drive of 100 miles in this same area I saw only one gully in cultivated land. This is remarkable, for the soil in that province is lighter and shallower than further south and is short of humus. This lack of erosion is accounted for by strip cropping, crop rotation and a very good system of terracing, evidently of ancient origin, all of which are more thorough in the north than further south. I had the benefit of travelling from Quiha near Macalle to Dessie with a South African officer who had spent 10 years in the administration of Basutoland, where erosion is very bad and where large and expensive control measures have been adopted. He agreed with me that the problem in this country was of comparative minor significance.

As my tour proceeded, however, I realized that the problem of soil conservation existed, though not on a scale comparable to that in many other countries.

The most conspicuous form of erosion is undoubtedly what one would normally call cattle-track erosion, but which is really caused not only by cattle and sheep being driven to market but by the large number of transport animals, horses, mules and donkeys carrying produce to market. This form of erosion is far

[1] The correct botanical name for carraway seed is *Trachyspermum ammi*, commonly known as Ajowan.—P.J.G.

[2] Derris. Readers of the *Journal* will be familiar with this crop, which is still in great demand. It could not be expected to do well with a rainfall of less than about 45 in. and, in the latitudes of Abyssinia, above about 5,000 ft.—Ed.

[3] Stramonium. The demand has altered since this was written.—Ed.

[4] Khat is a stimulant-narcotic, its principal alkaloid being nor-d-pseudoephedrine, but in too small quantities for the leaf to be of value commercially as a source of this alkaloid—P.J.G.

[5] The British Pharmaceutical Codex gives particulars: the active principle is known as kosotoxin.—Ed.

[6] Specimens of *Inkoko* received at Amani from Major Joyce have been identified as *Embelia schimperi*. I am not aware that this species has been chemically investigated, but other species of *Embelia* are quoted in the B.P.C. as providing the tape-worm remedy embelia.—Ed.

more marked near Addis Ababa, Harar, Jimma, Soddhu and other large markets. The well-graded Italian roads zig-zag up and down the hills, but the pack animals go straight and cut deep tracks, and more often than not the road drains lead into these tracks and contribute to the damage. Except for horse-drawn rickshaws in the main towns, animal-drawn carts or wagons are unknown. The road development by the Italians was followed up instantly by the introduction of Diesel lorries, many of 10-ton capacity, so the need for ox carts did not exist.

I believe this track erosion due to pack animals is not very serious. It is ugly and catches the eye, but many of these tracks are now stabilized by being eroded to bedrock.

Severe gullies in cultivated land are often caused by road drains. On a larger scale gully erosion can be seen in the rolling downs south of Harar, where gullies have formed about every half mile. Many of these gullies have now been stabilized as dongas or wadis, with bush and scrub.

A more insidious form of erosion is sheet erosion, especially near big market towns where large blocks of cereals are grown. There is a large masonry dam made by the Italians in a valley about 10 miles from Addis Ababa on the Addis–Alem road. When I first saw this in early November it was a large lake. By January it was dry and the millions of tons of silt that had come down from the surrounding wheat and barley fields could be seen.

The Ethiopian farmer, however, is erosion minded. Evidence of this is visible all over the country. I quote a few cases in the following:—

(1) Bench terracing and sometimes even box terracing of "Khat" and coffee in the Harar Province.

(2) The permanent terracing to be seen in many parts of the country. I saw one of these terraces being made in the hills near Decane, some 30 miles east of Jimma. A line of wattling was put up on the contour. This catches and holds the wash; shrubs and trees soon take root and the result in a few years is a natural hedge with a drop of a few feet on the lower side. The finished article can be seen all over this country.

(3) On rocky hillsides rough stone walls are often built on the contour to hold up wash.

(4) In most of the steep, small cultivated plots I saw in Caffa the weeds were piled up yearly on the same contour line and the result was a very well-terraced field completely free from erosion.

(5) Contour ploughing is universal.

(6) Strip cultivation. I saw an interesting case of this on a very steep unterraced slope in the Jimma Province, where newly planted grain and pulse crops were coming up below well established barley, so getting the protection, from run-off, of the previously planted crop. The system in fact was one of planting the lower strip only when the strip above was established.

(7) Finally there is the universal system of diagonal drains, made by one plough-furrow across their fields at intervals of 10 to 20 yards. Even where there are permanent terraces or temporary contour drains these diagonal shallow drains are put in, usually at about half the maximum hill slope.

In the sandy semi-arid country to which I am accustomed each one of these would have become a small gully in the rains; but I saw no case of their having washed, so they must do good.

These existing soil conservation practices are quoted rather fully in order to show that the people are erosion minded, and therefore that further soil control measures should get the support of the peasant farmer.

There are large blocks of cultivation where sheet erosion, though not apparent, is taking place and should be stopped. I heard of one steep hillside in the Gojjam some 20 miles north of Debra Marcos, where there is a field of barley of at least 2,000 acres without any attempt at terracing, other than the usual diagonal furrows. The barley was about 3 ft. 6 in. high, a heavy crop and a very fair sample of grain, but the fact that such fields exist shows the need for some additional form of soil conservation.

It is noticeable that on the large Italian tractor-ploughing schemes, both at Fadis and East of Ambo erosion and gullying are more marked than elsewhere and this land is in better hands as it is now, i.e. reverted to the small native cultivator.

The well-educated young Ethiopian, especially if a large landowner, is inclined to think in terms of tractor ploughing. Many of the hillsides could not be ploughed on the contour by tractors and tractor ploughing should be discouraged.

My recommendations are:—

(1) That if in the future any concessions are granted which entail large-scale arable farming it should be an essential condition that all ploughed land be broad-base terraced according to modern American specifications and practice, and

(2) that the peasant farmer be gradually taught a simple hand-terracing system such as is now being applied in some of the native reserves in Kenya.

The use of the line level is easy to pick up and no great skill is required. It may take a decade or more to see useful results, but it will be worth while. A start might be made by asking the Agricultural Department of Kenya if they would take a few intelligent young Ethiopians for a course of training under an Agricultural Officer in one of the reserves where this is going on. It is possible that on account of reduction of staff they would not be able to undertake it till after the war.

For the rest, all schools in the country should be given an agricultural basis, with special stress on the insidious danger of soil erosion.

If in the course of time a leavening of young Ethiopians can be passed through such educational centres as Makerere college in Uganda the general progress of the country will be accelerated, but I do not attach much value to long courses of instruction at European agricultural colleges.

Communications, Transport and Power

It is safe to assume that roads will deteriorate rapidly. Many of them should be maintained at least at dry weather standard for bringing as much agricultural produce as possible to markets. I suggest that any money available for road work be spent primarily on maintaining the drainage system. If this is allowed to go any money spent on surfacing will be wasted.

Petrol and oil must be saved, and shortly most of the cars and lorries will be out of action for lack of spare parts. Most of the transport will then devolve on pack animals as in fact it always has, except on the main roads. Ox carts and wagons will probably be evolved and a number could be made out of derelict cars and small lorries. It should not be forgotten that the trek oxen's feet will not stand up to existing Italian roads as long as the metalling lasts.

If in due course new lorries are imported, I suggest they be the kind that run on charcoal gas. These have been highly developed in Europe and will save the cost of importing petrol and fuel oil. Lubricating oil will always have to be imported.

In regard to power for all stationary purposes preference should be given, for the same reason, to charcoal (producer) gas. engines and, where supplies of firewood are ample, to steam.

Wherever possible water power should be used. I have seen a number of sawmills in the country which used to be worked by water, now converted to I.C. engines or electric power. They should be converted back to water power.

Though it hardly comes in the sphere of this report I suggest that, after the war, electric lighting sets run by windpower be imported. The best now made are efficient and considerable reduction in imports of lighting oil should result.

Agricutural Industries

Many of the existing ones have already been referred to in this report. They include tanneries, cord and sack factories, sawmills, flour and oil mills, soap factories and cotton spinning and weaving. All of these should be maintained or gradually developed, as the case may be.

It is not necessary to connect the word "industry" with large factories. Much can be done by village industries without expansive machinery. I refer more particularly to hand spinning and weaving, pottery, carpentry, skin and hide dressing, and so on.

In the interests of better health resulting from better housing, brick-making by hand should be encouraged.

More ambitious and remote possibilities include a tanning factory if Black Wattle plantations prove successful and an essential-oil still for converting to this purpose the thousands of tons of leaves of Blue Gum (*Eucalyptus globulus*) available in Addis Ababa.

General

Under this heading I have a few remarks to make on a wide variety of subjects all closely connected with agriculture.

Health.—Doctors will agree that a good and varied diet (nutrition) and clean healthy surroundings (sanitation) contribute more to the health of a nation than drugs and vaccines.

A sound agricultural policy will go far towards ensuring a reasonable standard of nutrition, and the maintenance of that standard ultimately depends, especially in a country such as Ethiopia, which produces all her own food, on the maintenance of the land. This is one of the reasons that I have put such stress on soil conservation.

Land Settlement.—If it is not already being done, a plan should be made and put into operation as soon as possible for the re-settlement on the land of—

(*a*) those who left it for employment by Italians on roads, in factories, etc., and

(*b*) the Ethiopian refugees who have come back from Kenya.

These people cannot be absorbed in the labour market and I have seen too much good unused and unoccupied country in the course of my travels to believe there can be any unsurmountable difficulty in putting these people back on the land. There they can at least support themselves and contribute, through their agricultural produce, to the revenues of the country.

Some, no doubt, have been absorbed in the Army and Police services, but who can blame those who are left to shift for themselves if they become "Shiftas"?

Relations Between Peasant and Soldier.—By the term "soldier" I now refer not to the regular soldier of the Ethiopian Army but to the armed followers of the various governors and chiefs.

One day I gave a soldier a lift in my car. I asked him what his pay was and he told me two quintals of millet per month. He naturally could not eat this amount nor, he assured me, could he sell it in that rather remote place for a sum which would enable him to buy the meat and fat he required. He looked well nourished.

I did not meet the peasant who had grown those two quintals of millet or who had supplied the extras, but I doubt if he was feeling complacent about it.

This country will not prosper unless the peasant gets fair treatment and until the soldier ceases to look on the peasant as someone put into the world to provide for his (the soldier's) comfort.

The peasant farmer should be the backbone of the Ethiopian Army as he is of all other armies in the world. I suggest that the best means of establishing good relations between peasant and soldier in this country would be the payment in cash of a good salary to all provincial governors and sub-governors: such as would enable them to pay at least a reasonable subsistence allowance (also in cash) to their followers. The money would be better spent in this way than in an expensive so-called "Agricultural Department" in the capital, whose only real activity, as far as I have been able to judge, is collecting the agricultural tithe tax.

If the peasant gets security and peace he will prosper and be only too willing to pay his share, and a large one, towards the revenues of the country.

APPENDIX I

PRINCIPAL IMPORTS

Average for Ten Years Previous to Italian Occupation in Round Figures

Cotton, raw and piece goods	7,500 tons
Sugar	1,500 ,,
Salt	1,200 ,,
Petrol	700 ,,
Iron and Glassware	600 ,,
Bags	500 ,,
Soap	300 ,,
Motor vehicles and parts	200 ,,
Rice	200 ,,
Tobacco	75 ,,

PRINCIPAL EXPORTS FOR SAME PERIOD

Coffee	15,000 tons
Hides	7,500 ,,
Skins	2,000 ,,
Cereals	2,000 ,,
Beeswax	350 ,,

APPENDIX II

Ethiopian Rainfall Records

Adua	33	inches per annum in	97 days
Gondar	50	,, ,, ,, ,,	118 ,,
Coram	38	,, ,, ,, ,,	90 ,,
Dessie	47	,, ,, ,, ,,	95 ,,
Southern Shore of Lake Tana	51	,, ,, ,, ,,	115 ,,
Addis Ababa	49	,, ,, ,, ,,	139 ,,
Harar	36	,, ,, ,, ,,	84 ,,
Jigjigga	24	,, ,, ,, ,,	? ,,
Belet Wen	10	,, ,, ,, ,,	22 ,,
Asba Tafari	45	,, ,, ,, ,,	? ,,
Rift Valley near Lake Zwai	23	,, ,, ,, ,,	78 ,,
Neghelli and Moyale about	24	,, ,, ,, ,,	? ,,
Jimma	64	,, ,, ,, ,,	? ,,
Bonga	72	,, ,, ,, ,,	? ,,
Gore	70	,, ,, ,, ,,	177 ,,
Gambeila	50	,, ,, ,, ,,	103 ,,
Danghila	55	,, ,, ,, ,,	148 ,,

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SOME EXPERIMENTS IN THE MAKING OF BUTTER, GHEE, AND CHEESE FROM CAMELS' MILK

By Harvey S. Purchase, Ph.D., F.R.C.V.S., Veterinary Research Officer, Department of Veterinary Services, Kabete, Kenya

In the Northern Frontier District of Kenya, there are large numbers of camels which are used by their owners for transport and for the production of milk and meat. At certain seasons of the year there is, in some districts, more milk than can be utilized. In some areas such as in the Arbo-Habbaswein district large herds of female camels and their young are congregated during the wet seasons around certain favourable grazing localities. During this period many of the owners and their families are on the move, separated from the milch camels, and, therefore, unable to obtain milk or milk products. No camel products are, of course, exported from the Northern Frontier District.

With a view to investigating the possibility of producing a milk product that can be stored, Mr. Murray, Stock Inspector, was detailed to visit Wajir to study the production of ghee from camel's milk.

Six samples of bulked milk and 25 samples of milk from individual milch camels were analysed for butterfat content. The specific gravity of the six bulked samples was also ascertained.

Individual Camels.—The butterfat content varied from 3.4 per cent to 4.4 per cent, the distribution in the 25 samples being as follows:—

1 sample	3.4 per cent
2 samples	3.8 per cent
7 samples	4.0 per cent
2 samples	4.1 per cent
1 sample	4.2 per cent
11 samples	4.3 per cent
1 sample	4.4 per cent

These figures were obtained under laboratory conditions, using the Gerber method, by Mr. F. Lyons, at Kabete.

BULK SAMPLES

Designation	Butterfat	Specific Gravity	Temperature of Milk	Temperature of Room
	Per cent			
1	3·9	1·022	81°F.	89°F.
2	3·5	1·025	80°F.	88°F.
3	4·1	1·024	80°F.	88°F.
4	3·6	1·022	81°F.	89°F.
5	3·6	1·024	80°F.	89°F.
6	3·9	1·023	81°F.	89°F.

These readings were made at Wajir, using the Babcock technique. Kheraskov's (1938) figures are 4.47 per cent to 5.39 per cent for some individual samples, but when handling camels' milk on a semi-commercial scale, his bulk samples had a range of 3.5 per cent to 3.8 per cent butterfat. He found the specific gravity to be 1.023—1.033.

Solids.—The 25 individual animal samples were bulked and yielded 800 cc. of milk. This gave on analysis a total-solid content of 12.4 per cent, whilst Kheraskov found the total-solids in his individual samples to vary from 13.16 per cent to 14.98 per cent. The average butterfat content of the bulked Kenya sample was 4.1 per cent, thus giving the figure of 8.3 per cent for solids-not-fat.

No difficulty was experienced in separating the cream, and thick or thin cream could be obtained at will. The milk passed through the standard dairy separator at a temperature of 80—84°F.

Cream was kept for 43 hours in a room with a temperature that varied between 83° and 90°F., and when soured it had no butyric odour, but smelled more like native beer. The butter was churned without difficulty; the break taking place in 10 to 33 minutes in a room temperature of 83°F. The butter was dead white and floated in the churn as a thick, frothy mass. When removing the buttermilk it was found difficult to avoid losing some of the butter as this was in a very fine granular condition. The washed butter was very white and had a waxy feel.

Ghee was obtained without undue trouble either from butter or by the direct method from washed cream. Some of this ghee was tested as a domestic cooking fat. With foods having a definite flavour, such as poultry, mutton and beef, no additional exotic flavour could be detected. However, when used for cooking pancakes, chipped potatoes, or for the making of pastry, a definite peculiar flavour was present. This flavour is best described as "camel". Kheraskov (1938), however, states that except for certain food taints, camels' milk has no specific taste or smell.

The following table gives the yield of butter and ghee obtained from camels' milk:—

Milk	Acidity percentage equiv. Lactic Acid	Cream	Percentage butter-fat in skim	Butter	Ghee	Yield of ghee per 100 lb. of milk
Lb.	%	*Lb.*	%	*Lb.*	*Lb.*	*Lb.*
66	0·46	15½	0·1	2¼	1¼	1·9
60	0·16	10½	—	2¼	1¼	2·1
80	0·53	12	0·5	2¼	1¾	2·2
40	0·40	5	0·05	Direct	¾	1·9
40	0·16	6	0·1	1	¾	1·9
200	0·14	16	—	Direct	4	2·0

It is necessary to mention here that the only weighing-machine available at Wajir was a small domestic balance. The low yields of ghee are probably due to the very primitive apparatus used in rendering and separating the ghee. These consisted of *debis* (4-gallon tins) and domestic cooking-pots. Dhingra (1934), in N.W. India, obtained 2.0 per cent to 2.5 per cent of milk fat by churning fresh milk and separating off the water and caseinogen.

Physical and Chemical Characters of the Ghee

A sample of the ghee prepared from butter was analysed by Mr. J. R. Hudson. The ghee was almost white in colour and appeared waxy in texture. After cooling at -5°C. the colour was pure white. When melted, the fat resembled a very pale sample of olive oil. The melting point was between 43.5° and 44.7°C., and the solidifying point was 34° to 35°C.

Readings with a Zeiss butyrorefractometer had to be made at about 45°C. After correcting to 40°C. the reading was 49.24, giving Nd^{40} 1.4588. With daylight there was no appreciable fringe.

The most striking character of the ghee was its low Reichert-Meissl value of 1.1. It would appear that the ghee is almost free from butyric acid esters. Actually the ghee has no butyric odour and smells faintly of mutton fat.

The low saponification number reflects the low proportion of small molecular weight fatty acids; whilst the relatively high iodine value indicates a greater percentage of unsaturated fatty acids than is found in ghee prepared from cows' milk.

The following table gives the range of values found in samples of bovine ghee, the values for the sample of camel ghee prepared by Mr. Murray and figures from Kheraskov and from Dhingra for comparison:—

	Range of bovine ghees	Local Kenya camel milk-fat	Kheraskov's U.S.S.R. camel milk-fat	Dhingra's India camel milk-fat
Melting point	28-38°C.	43·5-44·7°C.	44·5°C.	—
Solidifying point ..	19-30°C.	34°-35°C.	25·0°C.	35·3°C.
N_d^{40} ..	1·4527-1·4566	1·4588	1·4607*	1·4555
Reichert-Meissl No.	21·8-34	1·1	2·85	16·4
Polenske No.	1·1-3·5	0·5	—	1·6
Saponification No...	219-241	217	209·3	259·0
Iodine No...	26-40	43·8	39·0	40·8
Titre	33-37°C.	38·3°C.	—	—

*Calculated from refractometer reading given.

The ghee prepared by the direct method was of a very light brown colour.

Cheese-Making

Several attempts were made to clot the milk with rennet. All failed to produce a satisfactory curd. If excess of rennet was used, that is 50 to 70 times the amount stated on the labels as required to curdle cows' milk, a very light friable curd was obtained. When this was drained on butter muslin all the curd passed through the strainer. On the return of the remaining rennet tablets to Kabete, these were tested with cows' milk and found to have deteriorated in curdling power to half the strength given on the label.

Three cheeses were made from naturally soured milk and pressed, by means of a small, hand-operated, meat-extract press. Finally, they were preserved by immersing in hot sheeps'-tail fat. This fat, from the broad-tailed, black-headed local sheep, made a good protective covering and the cheeses travelled satisfactorily from Wajir to Kabete. These cheeses were then ripened in the cold chamber at 5° to 10°C. From time to time they were examined and tasted. At the end of two months the cheeses developed a good, green venation, due to infection with *Penicillum rocqueforti,* which during previous experimental work on cheese moulds had established itself in the cold chamber used for ripening cheeses.

The cheeses developed a full cheesy flavour, but superimposed on this was a definite, peculiar camel flavour, which was rather

bitter. The bitterness was probably due to the growth of unfavourable and deleterious contaminants, but the camel flavour was typically that associated with the odour of living camels.

These cheeses were very granular, friable, and white in colour, except where the gorgonzola mould had established itself.

Discussion

Since these experiments were completed a communication from the Imperial Bureau of Dairy Science has been received through the favour of Captain E. Peck, of British Somaliland. In this, Mr. G. Sutton gives a translation of a paper by Kheraskov (1938). It is of interest to compare the Kenya results with those obtained in Russia. The Russian worker did not report any difficulties in separating the cream from the milk, neither did he report churning troubles, but mentions that the butter was white, and, when it rose to the surface, was scarcely visible, forming a thick foamy mass. This is in full accord with Kenya experience. Furthermore, the Kenya observation that camel butter is tallowy is confirmed by Kheraskov, who also quotes the reports of Lakoz and Karatava *et al*. The latter authors described the butter as crumbly and the taste as greasy or tallowy.

Kheraskov churned his cream at low temperatures. For instance, his water for washing the butter was 12° to 17°C. He states: "It appears, from our experiments, that the peculiar taste noticed by other observers can be avoided under properly controlled conditions. The greasiness (or tallowiness) of the butter is due, not only to the characteristic properties of the milk fat, but also varies according to the method of manufacturing. We think the greasiness could be diminished firstly by appropriate feeding of the camels, and secondly by carefully controlling the conditions of manufacture". He reports that rendered butter may be used for cooking and confectionery.

Dhingra (1934) gives an account of the composition of the fat of camel's milk. He states: "The fatty acids of the milk fat of the camel differ from those of the cow . . . . in a lower content of fatty acids volatile in steam". His figure for the Reichert-Meissl value is, however, considerably greater than that obtained by Kheraskov or at Kabete.

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"TO HOE OR NOT TO HOE"

Gardeners are, as a class, highly conservative and inclined hotly to contest suggestions that their time honoured practices are open to criticism. In June, 1942, Dr. Bernard Keen, Rothamsted's soil physicist, dropped a bomb in their midst by a broadcast talk to gardeners setting out his conclusions drawn from a series of experiments on cultivation of the soil. He told the home gardener that hoeing of growing crops was, apart from eliminating the competition of weeds, a waste of time and further, cruellest blow of all, the theory that hoeing prevented loss of water by breaking the capillary spaces between the soil particles was just bunk. The soil, he said, formed its own mulch as the top layer dried out.

A storm of protest at once broke out in the columns of *The Gardener's Chronicle* and still rages. Could this revolutionary precept be taken seriously? College trained correspondents recalled the demonstrations of soil capillarity in the lecture room and many referred to the teachings of Hall and Russell in the standard text books of the day. Others more practically minded made hasty experiments or, from memory, quoted the evidence of their own eyes. A newly hoed row looked better than an unhoed one and thus confounded the theorists.

That it is of more than passing interest to farmers and gardeners in Kenya, where the sun is hot and labour often difficult, there can be no doubt. Do we hoe too much? Too vigorous a wielding of the *jembe* may, with some surface feeding crops at any rate, do more harm than good. Should this be replaced by the gentler treatment of the Dutch hoe or will the future cultivator be content with the sprinkling of some weedicidal chemical? Be this as it may, perhaps our East African experts will now, along with "A. Hoer" and others, enter the arena and in the pages of the *Journal* settle what is, in gardening circles in England, perhaps the most discussed topic of the day.

R. M. NATTRASS.

Footnote.—We hope to reprint an article by Dr. Keen on this subject in our next issue, together with an appreciation by an East African soil chemist. It should be remembered that Dr. Keen's experiments were carried out in England and therefore his conclusions may not be applicable to the tropics where an entirely different set of conditions operate.—*Editor*.

AGRICULTURE IN THE SOMALILAND PROTECTORATE

By E. F. Peck, Veterinary and Agricultural Officer, British Somaliland

The Somaliland Protectorate is potentially a rich grazing land, from which Somalis obtain their livelihood by raising sheep, camels and other stock; arable agriculture plays only a small part in its internal economy, but with the steady adoption of sorghum as the staple diet of the people farming is becoming more general. There are not, however, many places in which farming can be carried on, but there still remains a number in which arable agriculture would be worth trying. That enterprising person, the so-called Mad Mullah, who caused considerable trouble and expense to us in past years, cultivated many places which are not worked to-day, but which could yield crops of grain. The urge to settle seems to be latent in Somalis and if they are given suitable conditions many of them would prefer the sedentary life of a farmer to the hard nomadic life which is now their lot. This nomadic life amongst depleted pastures continually necessitates the breaking up of families in order to tend the stock, the camels being sent to one grazing and the rest of the stock to other more suitable pastures. It is this arduous life and the search for grazing which is driving the Somalis southwards; they do not want to leave their country, and usually in their later years they return to it, but when there is not enough grazing the compulsion to push on southwards is irresistible. The present lot of the Somali, particularly that of the women, is extremely hard, their environment is grim and cruel, comfort and real happiness are not theirs, and those who decry the Somali would do well to remember his environment. To the south of Somaliland lie many miles of rich grazing land which the *Pax Britannica* has made available to everyone. This land is sparsely watered and so is to a very great extent unused, but with a little imaginative foresight it is capable of arresting the southward drive. Should many large dams be constructed in this area and markets be provided for the excellent Somali mutton, the reason for the exodus from home would cease to exist, that is always provided that the grazing and water were properly controlled.

In this pastoral country of Somaliland there is a single-handed Veterinary and Agricultural Department, which deals entirely with native affairs; European settlement does not exist. Although it is arable agriculture which will be discussed in this article, it is without question the pastures which demand the greatest attention, and to keep pace with improvement of pastures the cultivation of markets is vital; it is only after the pastures have been improved and the markets have been gained that an attempt should be made to conserve the lives of domestic stock, and even then this matter should be treated entirely on a selective basis, and only those lives which are strictly useful should be protected against disease. The cessation of raiding has indeed brought with it the agricultural problem of destructive increases of both men and stock.

The Somaliland Protectorate as a whole may not untruthfully be described as a country in decay. It would form an ideal locality for anyone wishing to found a school for the study of soil erosion, and indeed, we have every type of erosion. But it is not pastures which we are to discuss, but rather the arable areas of the country. These areas are situated for the most part at four to five thousand feet, and they are blessed with a rainfall of some 15 to 18 inches in the better years. The rainfall figures are, however, misleading, as it is the Somali practice to bring water to the farms from the surrounding land, which is often hilly and stony, by means of roughly ploughed furrows. The soil on most of the farms is good, calcareous, reddish, medium, sandy loam.

The main idea in Somali farming is to grow sorghum, and in view of the fact that he has only been farming some twenty years or so, it is not surprising that he has no great variety of crops. He has no agricultural neighbours to influence him except the Abyssinians, and their influence has been only slight. Gradually he is being taught that there are other crops in the world than sorghum. When first, only a matter of seven years ago, I tried to introduce a new type of sorghum it was termed "poison", and few would have anything to do with it. The Somali has now learnt to try new seeds and will readily take them, but he is not slow to ask who is going to eat them, and buy them, and expresses himself as being quite satisfied with his sorghum and unwilling to cultivate new crops to any extent unless he can see a market for them.

The temptation exists to plough up many parts of Somaliland which are now pastoral and eroding, but which could, nevertheless, be terraced and made to grow uncertain crops, but one has seen the wholesale ploughing up

of pasture in other countries and its subsequent abandonment within a generation, and it is not a pleasant sight nor one which I wish to see repeated here. How difficult it is, even when writing on the subject of arable agriculture, not to have continually brought before one the terrible destruction of tree and grass which has been caused by the European-created common grazing lands, and hopefully but vainly to seek, in a wider application of dubious arable farming, an alternative remedy to a Protectorate grazing scheme. The situation in many places has come to such a pass that it is better to allow common land to be closed for farming than to allow it to remain common land, for at least under closure vegetational cover results.

In the introduction of new seeds and the quest for a market it is essential to interest "the trade", but their stock reply is "you grow the crop and then we will see if we can buy it", and so a deadlock arises between the cultivator and the merchant. In the end Government purchases the new crop for use in either human or animal rations, the Agricultural Officer meanwhile offering a prayer that the grower may himself acquire a taste for the new crop and so develop a market of his own. In the matter of marketing, the war has at least brought the blessing that local foodstuffs of all kinds are in demand. Prior to the war most of our foodstuffs came from India and the staple grain was rice and not sorghum.

So far as arable agriculture is concerned, the people have not been farming long, but nowadays they are receptive of ideas so long as they can see a rupee at the end of them within a few months; no real system of farming has been evolved and there are opportunities of agricultural development; in fact, the country bristles with agricultural problems. It is a land in which it is easy to make two blades of grass grow where only one grew before, and much has been done to improve the farming methods of the people, but the difficulty of markets, both internal and external, is one which limits agricultural progress, and until this problem is solved Somalis cannot help living a life full of hardship and discomfort. There are plenty of vital problems awaiting the agriculturally minded.

A typical farming area is one surrounded by low rocky hills probably some four or five miles away from permanent water. Sometimes a dam is built which will give a few months' casual supply, but most of the water has to be carried by camel-back. Up to twenty farmers may agree to house their families inside a large communal fence of cut bush, and here they erect their portable huts, and will, for mutual help and protection, farm together. The Somali is a year-to-year farmer; desert life does not lead to the formation of a character of long-sightedness; he has no care for to-morrow or for the state of his land in future; and should this season prove to be a bad one, he is quite likely to go stock-farming next year, and perhaps for several years after as well. He has no effective tribal organization or chief, and he does pretty much what he likes; and in these circumstances propaganda must be strictly utilitarian if it is to be effective. Experimental demonstration gardens he does not appreciate, and he probably has much the same idea about them as I have had myself, in short, that the folk who run them do not have to make their living from them. There are a few experimental gardens in Somaliland, but they are used for seed production and for the trial of new types of seed in a rough and ready manner. Circumstances are such that it is not possible to conduct careful experiments, even were this desirable, for when the experiment is made the acid test is whether or not the farmer is willing to grow the crop, and he will only know this when he has made his own experiment and tried to sell the resulting crop. It is customary here, when the introduction of a new crop is desired, to give the seed to the farmers and ask them to plant a little as a trial. This evokes an interest in the crop which is, of itself, good propaganda; the whole country is an experimental plot, and it is one which is not subject to local vagaries of the weather; new seeds survive if they are able.

The Somali is a crude cultivator. He has one implement, and to my way of thinking it is an excellent one for its purpose. It is the ancient wooden plough with a steel point; it costs but a trifle and is drawn by two bullocks. Out of date it may be, but it has virtues. It does not pulverise the soil to dust and it ploughs deeply enough but not too deeply. (I have not observed that deep ploughing on our soils is advantageous.) The plough is subsequently used as a cultivator; the farmer skilfully works his bullocks and plough along the contour between the standing crop of maize or sorghum and thus at one stroke he effectively cleans and lightly ridges his fields. The fields are normally ploughed up and down the slope in winter or late spring in preparation for the first rains, but later cultivations are usually along the contour. There are exceptions to this: for instance, when the crop at the bottom

of a field seems to be going short of water, then the field will be ploughed up and down regardless of erosion. Erosion means nothing to the farmer, but this year's crop means everything, and who can blame him? Another time when the field is ploughed up and down the grade is when gram (*Cicer arietinum*) is grown and it is feared that the crop will get too much water and so grow to leaves and not to grain. Then the ploughing is used to drain the field.

It seems that the reasons for ploughing up and down the hillsides are so cogent and so very difficult to eradicate that it is better to condone the practice and meet the situation by developing a system of terracing, and to this end we applied ourselves some years ago. In imitation of a Somali who had already had this idea we began terracing by planting aloes along the contours in the hope of arresting erosion and stopping soil wash. Aloes did not prove to be a popular form of erosion control because it left the fields too narrow and so made it difficult to plough up and down the hill. The next step was the acquisition of a number of levels and the copying of the system of the levelling and contour making which has been described in one of the Tanganyika Agricultural Department Annual Reports. (And at this point let me say how very useful are all these Departmental reports in spreading new ideas and relating experiences. It is a pity that failures and disappointments are not mentioned in them to the extent that successes are, but then this is only human nature. Surely it is not helping the war effort to curtail them to the extent that they are at present?) It was no end of fun to teach the Somali staff the proper use of the levels, and it caused a deal of argument too. In fact, the teaching of the fact of a contour was an education in itself. The cardinal point in the Somali's mind when deciding the location for a terrace or ridge was always, not the levelness of the contour, but "the place where the water comes from". The inspectors now understand the difference between these two points of view, but I have yielded to the farmers, for is not half a terrace better than no terrace at all? Eventually, when the water goes sidling off their land, they will see the error of their ways, and in practice not much damage is done in the process of learning. With the levels came a couple of dam scoops, and with these we went to work making ridges with as much enthusiasm as we had planted aloes. I never did like the wholesale moving about of earth, and the treating of farm land like a road grade. It seems contrary to the very nature of things. The Somalis did not like our ridges either. The ridges themselves proved to be quite effective for the purpose for which they were made, but the farmers complained that the top one held all the water and kept the lower fields dry, and that overflows were not the easiest things in the world to control, and that sometimes the ridges broke and all the water was lost, and, in fine, they did not like them, and to show their dislike they would make gaps in the top ones and let the water run down the field. All of this was discouraging, and it was clear that, as a poor man's amusement, contour ridging, unless very carefully watched, was not to be recommended. This is not to say that there are no circumstances in which it is advisable to make earthworks, but it is to say that there are circumstances in which it is inadvisable. The next step in the construction of terraces was to go back to nature and to go slowly. The Somali, as has already been remarked, ploughs on the contour, and all that is now recommended in the making of terraces is to let one pace in every ten or so go permanently back to grass; in some cases the site of the new terrace is hand-seeded with some of the excellent local grasses. Our problem now seems to be answered, the grass grows up and holds the soil and lets the water through, and in a very short time one has the beginning of a terrace, and at no cost or effort to the farmer.

The system of agriculture employed in the cultivation of sorghum is of the most elementary type. It consists, in the case of the better farmers, of ploughing the land either in the dry season or in the late autumn, but generally the ploughing is of a hurried kind and takes place when the spring rains have broken, or are just about to break. At this time the rough irrigation furrows are ploughed or dug out, along which the rain water will eventualy flow from the surrounding hills. The seed is then broadcast and ploughed in to wait for the rain. Sometimes it may wait so long as to be destroyed and require re-seeding. Subsequent cultivations are done with the plough, usually after rain, and after about four months, or a little more, the sorghum is ready to cut. The harvest is reaped by means of a sharp curved knife, the stalks being stooked in the field to cure. Threshing is with the old-fashioned flay, either the jointed type or else the simple curved stick. After the first crop is removed the sorghum is left to yield a second crop. In many places, if the weather has not been particularly good, the second crop is left uncultivated, the

idea being that in these circumstances the farmer will be lucky to get a satisfactory crop, and the grass which will grow in the field can give grazing to the stock in the arid winter months. If the weather has been satisfactory the second crop is usually cultivated; in exceptional circumstances even a third crop may be obtained.

It sometimes happens that a man will be too poor to own bullocks or that there is not sufficient grazing in the vicinity of his farm for him to keep them, and in this case all the cultivation will be done by means of the primitive hoe.

Sorghum is stored almost exclusively in holes dug into the ground on the stony limestone ridges which adjoin the farm. The holes, which are well camouflaged by soil and stones, are just wide enough for a man to enter, but they are quickly expanded into cavities which will hold up to twenty bags of grain. The pits are kept sweet and clean by leading water into them during the rains and by smoke fumigation. If there is sufficient grain they are filled to the top and are then made as airtight as possible by means of flat stones embedded in cow dung.

The fertility of the soil is naturally an important problem when the chief crops are sorghum and maize; the farmer's methods do nothing to improve fertility, and the soil is steadily returning poorer yields. Most of the stover has to be carried up to the homestead and fed there to prevent stock-owning tribes from coming into the fields and stealing it. Laws have now been made to protect the farmer in the matter, but the making of a law is not the same thing as the enforcing of it. It is customary to pass the water which runs down off the hills after rains alongside the manure heap, and so to send some manurial material into the field. Many legumes have been introduced with the idea of improving fertility, but always there is the problem of finding markets for the produce. It does seem obvious that every Colony, however small, should have a business manager, well paid and capable, to organize markets, and in general to protect the natives against the wiles of the commercial interests. Administrators are seldom versed in commerce.

Very many crops have been introduced into Somaliland and comparatively few of them now survive. It may be worth while to discuss some of these successes and failures in view of the adverse circumstances in which they have had to struggle for existence. In addition to the rainfall being scanty it is broken into two periods by a regular mid-summer drought, insolation is very high and a strong dust-bearing wind increases the aridity. The best of the introduced crops has perhaps been green gram. This robust plant will be found growing when most of the other crops are droughted, and in this green gram is at one with the sturdy Somali green pea. It is a cheering sight to see a field of broadcast peas in flower in the midst of a drought. Black gram, while readily grown, is considered too bitter to eat. Groundnuts are an undoubted success, and when the Somali discovers that there is a regular market for this crop it will revolutionize his ideas of farming and will greatly assist in erosion control. Potatoes do not thrive, but sweet potatoes have proved themselves to be very drought resistant, and in time should come to have permanent place in our agriculture, for the general Somali criterion upon which any crop is judged is by its sweetness. The wild pigs and porcupines, which do so much damage to the sorghum and maize, have not yet discovered the sweet potatoes nor the groundnuts, and when they do they will make more troubles to hinder the introduction of these new crops; more shooting and poisoning will help control. Other oil crops which grow well are flax and sim-sim; the flax is dwarf and only has a small local market as a condiment, and nobody seems to want to buy sim-sim at all. Pigeon peas would perhaps be sown, but their growing season is too long, and when the returning stock in the autumn roam the fields crops cannot safely be left out. Some crops grow satisfactorily, but are not acceptable; bird-proof sorghum is a case in point; neither Somalis nor birds could eat it. Bulrush millet will not produce seed as the flowers seem to be killed by the drying wind.

I sometimes wonder if the Somali wheat and barley might not be of value to other countries for crossing, if this has not already been done. Both are very quick to mature, and in about two to two and a half months they are ripe for cutting. Usually quick-maturing crops are essential when they are to be grown under our conditions, but an exception is Muratha Maize. This maize, while taking somewhat longer than the local varieties to mature, is more drought-resistant and a much heavier yielder of both grain and stover. A quick-maturing crop of outstanding potentiality is a variety of milo which was obtained from the University of California some years ago. It has

the virtues of maturing in just over two months and as the stalks are light all of the stover is edible. Its chief use is as a famine crop, because it will quickly provide food for the farmer after a bad season. Some crosses of this crop appear to keep the quick-maturing quality, even though the second generation is quite a large plant. This milo might be useful for breeding work. Cassava has not proved to be a success, but it might be if better varieties could be found. Cotton could certainly be grown widely and successfully here, but it seems as though there will be no market for this crop for a long time to come. Crops which usually do well are cowpeas, pumpkins, gourds and melons. The melons themselves are sometimes grown in holes in the ground which are covered by their leaves as a protection against *Dacus* sp.

While plant introductions have been made from many countries, in general, only those from Kenya or the Sudan have proved successful, with the notable exception of the milo mentioned above. Seeds from America have as a rule been useless.

Our farmers, in common with their kindred all over the world, have many diverse troubles. Vermin, such as pig and porcupine, eat the maize and sorghum, but these are shot, trapped and poisoned; jackals, hyenas and lion prey on the stock, and are similarly dealt with. As sorghum is the chief crop, birds are a major pest which compel the farmer to cut down large areas of trees and so destroy the natural windbreaks. Of course, the answer to this bird problem is to diversify the crops, but this is more easily said than done, and the question of finding new markets immediately comes to the fore. In the meantime there is little choice but to wage war against the birds, virtuous in some respects though they may be. Many devices have been tried, rattles, bells on strings, bright objects flashing in the sun, and scarecrows; but it seems that there is nothing better than the old method of making a platform in the centre of the field, where all the members of the family take turns, wielding a sling which simultaneously throws dry mud and makes a rifle-like crack which for a short while frightens the birds away. A Sheikh remarked to me one day after I had been airing my views on bird control, and stressing that my ideas were held in many other countries, "Ah, but Somali birds are different!" And indeed, this applies to so much in Somaliland—Somali birds *are* different.

A problem which has so far proved intractable is the provision of a good stock-proof fence. It must, of necessity, be very easy to plant, unsuitable for birds to nest in or perch on with pleasure, quick-growing and drought-resistant, and not particularly edible for stock. Recently sisal has been suggested as meeting these requirements, but other suggestions will be welcome. Many plants have been tried: kei apple, prickly pear, spineless cactus, aloes, sansevieria, *Euphorbia* spp., osage orange, and some species of *Caesalpinia*, but none of them with any degree of success. This matter of fencing is important in so far as one cannot expect a man to look after a piece of land unless he feels that he is secure in the tenure of it and is protected against depredations of stock.

Lastly, the problem of the migrating Somali affects, and will affect, in increasing degree, all the East African territories. One of the major solutions to the problem clearly lies in making Somaliland a better place for the Somali to live in, by turning him into an arable farmer where this is possible, and where this cannot be done, by developing markets, water supplies, and a system of controlled grazing based on natural boundaries.

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SCIENTISTS AND EDUCATION

The scientist himself must be educated in the problems and needs of society; he must encourage in every way the development of what are called the social sciences, and must take the trouble to understand something of their content and methods. This is not to say that every chemist, physicist or biologist should become a specialized social scientist; but, as the biologist finds it necessary to have some knowledge of physics and chemistry, so also he must have some knowledge of, say, psychology, economics, political science, if as a scientist his opinion is to carry weight in social affairs. It is unfortunately true that most of us are deplorably uneducated in matters of this sort. Secondly, it is also essential that the non-scientific public should have more education than they have at present in the methods and principles of science in general, and of the ways in which these methods and principles are relevant to social development. It is only when these conditions are satisfied that a sympathetic understanding can develop between the scientist and the non-scientist, and without sympathetic understanding, co-operation will be impossible.

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FORESTS AND POST-WAR SETTLEMENT

By R. M. Graham, Assistant Conservator of Forests, Kenya

Many people regard forests primarily as a source of supply for timber, fuel or poles, and it is true that these are essential commodities. Nevertheless, it cannot be too strongly emphasized that in a country such as Kenya by far the most important function of forests is that of conserving available water supplies. Until this basic fact is recognized, not only by executive members of the Government, but also by those members of the public and of the Colonial service who have power to deal with the disposal of land for various purposes, there will always be the possibility of important or even vital water-catchment areas now under forest, bamboo or bush being given out for "development" to satisfy the demand by Europeans or natives for more agricultural land.

It is possible that some small areas of gazetted forest Reserves in Kenya could safely be excised for agricultural purposes without much harm being done. It is equally true that other areas, now under cultivation but recently under forest, should never have been denuded of their natural cover.

We know only too well what happens in many countries when, for reasons of political expediency, Government wants land. A glance at a map of any district in Kenya will usually show:—

(*a*) Native Reserve Land Units, which cannot be touched without inviting the most disturbing repercussions.

(*b*) Alienated farms, occupied or otherwise, sometimes for sale, but usually at a prohibitive figure.

(*c*) Unalienated Crown Land, now very small in extent.

(*d*) Government Forest Reserves, regarded by the uninformed as "waste lands" unless they happen to be carrying a crop of saleable timber.

A parcel of land may conceivably be a "white elephant", but it can never be a white rabbit, conjured out of thin air with the aid of nothing but a tall and glossy and demonstrably empty silk hat. We may understand the attitude of the harassed administrator who is ordered from Above to "find" land for a specific purpose; and to make his peace as best he may with the previous owner. It is more difficult to sympathize with those Above who have not, before now, caused joint surveys to be carried out, where necessary, by agricultural, veterinary, forestry and administrative officers, in order that land, in strategic centres at least, might be utilized in a proper manner.

A single individual may or may not have a sound working knowledge of agriculture, forestry and administration, but it is reasonable to suppose that technical officers employed by Government become tolerably competent in their respective spheres. Concerted action by all the Departments concerned is, therefore, far more likely to yield economically sound results than a land survey by officers of one or two departments only. These notes touch on a few points concerning the use of land so far as this affects Forestry. It is probably too much to hope for properly organized land-planning to precede the distribution of new farms after this war, but it is possible that some of those who will soon be wondering exactly how many acres can be carved off the inadequate Forest Reserves in Kenya, for closer settlement and development, will read these notes. They may not be convinced, but at least they will have been warned. It is true that in the 1941 Ordinance, which amended and consolidated the old Kenya laws relating to forests, provision was made still further to safeguard our Reserves by the following clause:—

> "5. (4) No forest area, or any portion thereof which has been declared, under the provisions of this section, to be a demarcated forest shall be withdrawn from demarcation except with the approval of the Legislative Council signified by resolution thereof. Twenty-eight days' notice of such resolution shall be given to the Legislative Council."

Even this, however, will not avail if the legislators do not understand the part played by the seemingly non-productive areas of Forest Reserve in the economy of the country.

There are countries, such as Finland or British Honduras, where forestry is acknowledged to be all-important since the bulk of the revenue of the state is derived directly from the sale of forest produce. No one pretends that forest royalties are the mainstay of our finances in Kenya, but the retention of considerable areas in Forest Reserves is still vital for other reasons. Here, according to the old saw, "Forestry is the hand-maid of Agriculture". Indirect benefits, rather than cash royalties on timber, are what matter most—or perhaps I

should say, are what ought to matter. Undoubtedly a very large proportion of the present gazetted forests should be converted into farms. It would only be necessary to cut out or burn the trees and to plant fodder grasses or agricultural crops in their place. Most of these potential farms would lie in areas of reasonably high rainfall. It is unlikely that the main rains would be adversely affected by the destruction of the forests unless this was carried out on a very large scale indeed, though it is possible and in fact probable that the frequency of local instability showers would be decreased and this inter-rains precipitation is often valuable in the drier districts. As a rule it is true to say that forests occur naturally in districts where good rains fall and the soil is suitable. But steady rains are normally confined to certain seasons. In dry weather farmers rely on streams, springs, dams or boreholes, which in turn are mainly dependant on the action of forests, including thick bush and bamboo, in holding up the flow of rainwater, and allowing it to be absorbed deeply into the soil.

Exceptions could no doubt be quoted, but the following are examples of percolation, or the lack of it:—

(*a*) A concrete or tarmac type of surface will absorb no rain. Water falling on it will flow until it reaches the sea, or a permeable surface, or until it has all evaporated.

(*b*) Bare soil will absorb a little, according to its texture and slope. If it has been ploughed recently it will absorb more; but when the ploughed layer is sodden, water will flow, carrying soil with it.

(*c*) Grazed grasslands will take up more than bare soil, according, of course, to the slope, to the type of soil and grass and to the severity of the grazing. Points worth noting are these: Land over which stock is grazed, particularly if the soil is heavy, is apt to develop a fairly impervious pan a short distance below the surface, due to trampling and puddling, during wet weather. In very dry weather the topmost layer of soil may be pulverized by trampling. If the grass is scanty the loose top soil is then apt to be washed away by subsequent heavy rains.

(*d*) Rank ungrazed grass will, of course, take up more water still, other things being equal. But there is little hay made in Kenya—in the literal sense of the words. And ungrazed grass that is not reserved for hay-making is of no value to anyone. Furthermore, grass fires often lay the soil bare for weeks before the rains each year.

(*e*) Land covered with dense bush, bamboo or forest will, in the natural course of events, absorb much more of the total rainfall than other types of surfaces. As there are several factors involved, it is worth going into this statement in a little more detail.

(i) Light isolated showers hardly reach the floor of the forest at all. The rain is intercepted by leaves and twigs and is subsequently lost by evaporation. In the open, such showers are absorbed more completely, but they are not really significant one way or another. The bulk of the moisture is lost almost immediately by surface evaporation and by transpiration through grass leaves.

(ii) Heavy mists deposit no water to speak of in the open, but in high-altitude forests, where such mists are of frequent occurrence, it has been shown that an appreciable quantity of water condenses on leaves and twigs, flows down the branches and stems and finds its way into the soil. Many of our forests over the 8,000 ft. contour are frequently enveloped in mist at night, and at certain seasons by day as well.

(iii) The roots of trees, grasses or crops are continually taking water up from the top soil. This water eventually passes out into the air through pores in the leaves. Trees, particularly the large and fast-growing types, like many *Eucalypti*, naturally take more water out of the soil than do scanty grasses, and they draw it from deeper soil layers.

(iv) On the other hand, the main drying agency in nature is a desiccating wind. Water is always being drawn from the subsoil towards the surface in dry weather by capillary action. In the open the action of the wind leads to rapid evaporation. In a closed forest, the temperature of the air is lower, on a warm sunny day, than in the open, and of course the force of the wind is entirely broken. Thus the humidity of the air inside a forest is relatively high, and consequently surface evaporation is much reduced.

(v) Soil rich in humus, i.e. a mixture of decaying vegetable matter and mineral soil, can retain a much larger quantity of water than can an equal volume of pure mineral soil. In a forest the depth and richness of the humus layer is normally much greater than is grassland, particularly where the grass is heavily grazed or frequently burnt.

(vi) The roots of large trees penetrate relatively deeply into mineral soil, murrum or even crevices in what appears to be solid rock. In time these roots decay, leaving

numerous permeable channels through which water can percolate rapidly downward.

(vii) Once the topsoil is saturated, the flow of surface water is impeded, as recently fallen twigs and leaves form numerous small obstructions. On sloping land covered by forest very little soil is lost by the action of water. Grass slopes subject to heavy grazing or to annual burning, absorb little rain, and are also liable to lose topsoil. Consequently they have a shallow humus layer.

If these seven points are considered, it should be clear that, on balance, a much larger proportion of rain falling on forest is absorbed deeply into the soil than is the case with similar rain falling on pasture or on cultivated land, particularly on hill slopes. It is mostly this water which is recovered in the form of perennial streams and springs, often at a considerable distance from the point at which the rain falls.

Once this vital point is grasped, it is a little easier to understand why it is so necessary to maintain relatively large areas of country under forest, even though much smaller areas could be made to produce all the timber or fuel needed for immediate local consumption. Many of our forests are, from the point of view of the saw-miller, unproductive. It is these so-called "waste lands" which will be in the greatest danger when the post-war rush for farms sets in. As pressure grows, ill-considered excisions might be made from Forest Reserves on the grounds that better use can be made of the land by farmers.

It would be a grave mistake to assume that all water catchment areas not now under merchantable forest should remain permanently unproductive. On the contrary, there are at least three obvious lines of approach to the problem of the economic utilization of such land:—

(*a*) A joint survey by properly qualified officers of all departments concerned should decide, first of all, what land, if any, can safely be excised at once for settlement. The same party could make recommendations for the creation of new Forest Reserves in the district, where these are desirable from the point of view of water conservation or of timber production.

(*b*) It is possible that in certain favourable localities the construction of large dams would conserve quantities of water for use on farms now dependent on streams rising in the forest. Such dams, holding water for irrigation, and possibly for hydro-electrical power, would make the best use of the ample rainfall of many parts of the Kenya Highlands. And this might release for agriculture land now necessarily kept under bamboo or forest.

(*c*) Where conditions are suitable, plantations for the production of timber for the local market and for export could be made by the Forest Department on a far larger scale than heretofore. There is no reason to suppose that the consumption of timber in Kenya will always depend in the main on the size of the white population, or that it will never pay to attempt to build up an export trade in Kenya-grown timber products. At present the consumption of forest produce by natives is confined almost solely to firewood and to split cedar slabs or poles for hut building. But almost every young native in Kavirondo or Kikuyu would have a hut of sawn timber—if he could afford to buy it. The potential market for cheap sawn timber is there. And as regards exports, although we have, in quantity, no indigenous timber for which there is a demand overseas, except cedar for pencil slats, we have the soil and climate necessary to grow good soft woods suitable for the manufacture of pulp or plywood. As regards the species to be planted, various opinions have been expressed, and the subject cannot be discussed in this article.

In Europe it is not uncommon to find 25 per cent or more of the total area of a state under carefully managed forests. The proportion of Forest Reserve in Kenya as a whole is nearer 3 per cent. This comparison is hardly fair; but if we consider only the so-called "White Highlands" we find that the proportion of Forest Reserve is still only about 8 per cent. Probably less than a quarter of the Reserves, including our 50,000 acres of plantations, can be classed as productive, merchantable forest at present.

To sum up: although some land in Forest Reserves might make profitable farms if the right areas were chosen, the total area of Reserves should certainly not be decreased but should, in fact, be increased very considerably. It will be infinitely easier for Government, after the war, to sell land for farms than to take it over for forestry. The results of an error in policy would not become apparent for some years, but they would be no less unpleasant, on that account, for those who have made Kenya their home.

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HOST LIST OF THE PARASITIC FUNGI OF UGANDA

PART II

By C. G. Hansford, M.A., F.L.S., Senior Plant Pathologist, Uganda Department of Agriculture

ROSACEAE—(Continued)

RUBUS sp.
- *Irene calostroma* (Desm.) v. Hoehnel.
- *Glomerella cingulata* (Stonem.) Spauld. & Schrenk.
- *Gnomoniella rubicola* Passer.
- *Hamaspora longissima* (Thum.) Koern.
- *Cercospora heteromalla* Syd.

CESALPINIACEAE

BAUHINIA sp.
- *Uromyces congoensis* Syd.
- *Uromyces* sp., cf. *U. goyazensis* P. Henn.
- *Armillaria mellea* (Vahl) Fries.
- *Alternaria Bauhiniae* Hansford.

CASSIA sp.
- *Ravenelia* sp.
- *Aecidium Torae* P. Henn.
- *Uredo* sp.
- *Ganoderma australe* (Fr.) Pat.
- *Heterosporium* sp.
- *Cercospora Cassiae* P. Henn.
- ? *Cercospora personata* (B. & C.) Ell. & Ev.
- *Camptomeris* sp.
- *Microstroma Albizziae* Syd.
- *Rhizoctonia lamellifera* Small.
- *Fusarium javanicum.*

CESALPINIA sp.
- *Stilbella fasciculata* B. & Br.

PIPTADENIA sp.
- *Nectria ochro-leuca* (Schw.) Berk.

MIMOSACEAE

ACACIA sp.
- *Ravenelia escharoides* Syd.
- *Rhizoctonia lamellifera* Small.
- *Fomes* sp.

ALBIZZIA sp.
- *Meliola bicornis* Wint.
- *Pseudothis* sp.
- *Phragmocauma viventis* (Cooke) Theiss. & Syd.
- *Eutypella corynestroma* (B. & Rav.) Sacc.
- *Ravenelia Zygiae* Syd.
- *Sphaerophragmium* sp.
- *Polyporus Fyffei* Wakef. (ined.).
- *Phyllosticta divergens* Sacc.
- *Phyllosticta ramicola* Petch.
- *Cercospora* sp.
- *Camptomeris Albizziae* (Petch) Mason.
- *Microstroma Albizziae* Syd.
- *Rhizoctonia lamellifera* Small.
- *Ravenelia Bottomleyae* Doidge.

ENTADA sp.
- *Ravenelia Schweinfurthii* Syd.

PAPILIONACEAE

ALYSICARPUS sp.
- *Uromyces Alysicarpi* (Doidge) Wakef. & Hansf. (ined.).

ARACHIS HYPOGAEA
- *Cercospora arachidicola* Hori.
- *Cercospora personata* (B. & C.) Ell. & Ev.
- *Sclerotium Rolfsii* Sacc.
- *Macrophomina Phaseoli* (Maubl.) Ashby.
- *Fusarium oxysporum* Schlecht., f.
- *Rhizoctonia bataticola* (Taub.) Butl.
- Rosette Disease.

ASTRAGALUS sp.
- *Uromyces Astragali* (Opiz.) Sacc.

CAJANUS CAJAN
- *Cladosporium Vignae* Gard., prox.
- *Cercospora Cajani* P. Henn.
- *Cylindrosporium* sp.
- *Rhizoctonia bataticola* (Taub.) Butl.
- *Fusarium oxysporum* Schlecht., f.
- *Fusarium herbarum* (Corda) Fr.
- *Fusarium Scirpi*, var. *caudatum* Wollenw.
- *Gibberella* sp.
- *Nectria* sp.

CANAVALIA ENSIFORMIS
- *Elsinoe Canavaliae* Rac.
- *Heterosporium lagunense* Syd. (?)
- *Verticillium* sp.

CENTROSEMA sp.
- *Alternaria tenuis* Bolle.
- *Cercospora* sp.

CRAIBIA sp.
- *Phyllachora Milletiae* P. Henn.

CROTALARIA sp.
- *Parodila perisporioides* (B.& C.) *Speg.*
- *Parodiella perisporioides* (B. & C.) Speg., var. *microspora* Theiss. & Syd.
- *Aecidium Crotalariae* P. Henn.
- *Meliola bicornis* Wint.
- *Neocosmospora vasinfecta* E. F. Sm.
- *Asterina scitula* Syd.
- *Sclerotinia* sp.
- *Uromyces Harmsianus* (P. Henn.) Doidge.
- *Uredo Crotalariae* Diet.
- *Phyllostica Crotalariae* Sacc.
- *Colletotrichum* sp.
- *Cephalosporium* sp.
- *Botrytis* sp.
- *Helminthosporium gigasporum* f. *javanicum* Penz. & Sacc.
- *Cercospora canescens* Ell. & Mart
- *Cercospora Demetrioniana* Wint.
- *Fusarium oxysporum* Schlecht., f.
- *Fusarium falcatum* App. & Wr.
- *Fusarium Solani* (Mart.) Wollenw.
- *Alternaria* sp.
- *Rhizoctonia bataticola* (Taub.) Butl.
- *Verticillium Dahliae* Klebahn.

DESMODIUM sp.
- *Parodiella perisporiodes* (B. & C.) Speg.
- *Meliola bicornis* Wint.
- *Meliola Teramni* Syd.
- *Meliola Desmodii* Karst. & Raum.
- *Meliola zollingeri* Gaill. var. *minor* Beeli.
- *Meliola bicornis* Wint. var. *Galactiae* Stev.
- *Meliola bicornis* Wint. var. *Tephrosiae* Beeli.
- *Phyllachora Desmodii* P. Henn.
- *Uredo* sp.

DOLICHOS sp.
- *Epicoccum* sp.

ERIOSEMA sp.
- *Woroninella Eriosematis* (P. Henn.) Syd.
- *Meliola bicornis* Wint.
- *Uredo* sp.
- *Aphysa ugandensis* Syd.
- *Cercospora* sp.

ERYTHRINA sp.
- *Meliola bicornis* Wint.
- *Mycosphaerella Erythrinae* Koord.
- *Uredo Erythrinae* P. Henn.
- *Armillaria mellea* (Vahl) Fries.
- *Rhizoctonia lamellifera* Small.
- *Cercospora tomentosae* Hansford.

GLIRICIDIA SEPIUM
- *Meliola bicornis* Wint.
- *Capnodium* sp.
- *Nectria flavo-lanata* B. & Br.
- *Calonectria rigidiuscula* (B. & Br.) Sacc.
- *Hypomyces haematococcus* (B. & Br.) Wollenw
- *Gibberella baccata* (Wallr.) Sacc.
- *Gibberella pseudopulicaris* Wollenw.
- *Fusarium decemcellulare* Brick.

GLYCINE spp.
- *Woroninella Dolichi* (Cooke) Syd.
- *Meliola bicornis* Wint.
- *Aphysa Rhynchosiae* (Kalch. & Cooke) Theiss & Syd.
- *Cercospora cruenta* Sacc. (?)
- *Rhizoctonia bataticola* (Taub.) Butl.

HALLIA sp.
Uromyces sp.
HEDYSARUM sp.
Uredo sp.
INDIGOFERA sp.
Parodiella perisporioides (B. & C.) Speg., and var. *microspora* Theiss. & Syd.
Meliola nyanzae Hansford.
Uromyces orientalis Syd.
Ravenelia sp. ("*R. Indigoferae* Wakef. & Hansf.", non Doidge).
Uredo Indigoferae Doidge.
Uredo maraguensis P. Henn.
LATHYRUS sp.
Uromyces Pisi Wint.
LONCHOCARPUS sp.
Gloeosporium sp.
Microthyriella Chandleri Hansford.
LUPINUS sp.
Rhizoctonia bataticola (Taub.) Butl.
MEDICAGO SATIVA
Uromyces striatus Schroet.
Macrophomina Phaseoli (Maubl.) Ashby.
Sclerotium Rolfsii Sacc.
MUCUNA sp.
Uromyces Mucunae Rabh.
Meliola bicornis Wint.
Cercospora mucunaecola Cif. & Frag.
Phyllostica Mucunae Ell. & Ev.
ORMOCARPUM sp.
Uredo sp.
PHASEOLUS sp.
Oidium sp. (? *Erysiphe Polygoni* DC).
Glomerella lindemuthianum Shear.
Mycosphaerella pinodes (B. & Br.) Vesterg.
Pleospora sp.
Erostrotheca multiformis Mart. & Charles in conidial stage, *Cladosporium album* Dowson.
Uromyces appendiculatus (Pers.) Link.
Macrophomina Phaseoli (Maubl.) Ashby.
Macrophoma sp.
Ascochyta pinodes B. & Br.
Ascochyta phaseolorum Sacc.
Colletotrichum lindemuthianum (Sacc. & Magn.) Br. & Cav.
Cercospora canescens Ell. & Mart.
Cercospora cruenta Sacc.
Isariopsis griseola Sacc.
Rhizoctonia bataticola (Taub.) Butl.
Rhizoctonia Solani Kuhn.
Speira punctulata Cooke & Ellis, var. *latebrosa* Bizz.
PISUM sp.
Oidium sp. (? *Erysiphe Polygoni* DC).
Macrophomina Phaseoli (Maubl.) Ashby.
Rhizoctonia bataticola (Taub.) Butl.
PSEUDARTHRIA sp.
Phyllachora sp.
Meliola bicornis Wint.
Uromyces Pseudarthriae Cooke.
Cercospora Pseudarthriae Petch.
PUERARIA sp.
Aecidium Vignae Cooke.
RHYNCHOSIA sp.
Aphysa Rhynchosiae (Kalch. & Cooke) Theiss. & Syd.
Uromyces Dolichi Cooke.
SESBANIA sp.
Uredo Sesbaniae P. Henn.
Rhizoctonia lamellifera Small.
Gibberella sp.
STYLOSANTHES sp.
Uredo Stylosanthis P. Henn.
TEPHROSIA sp.
Elsinoe Tephrosiae Hansford.
Oidium sp.
Parodiella perisporioides (B. & C.) Speg.
Meliola bicornis Wint. var. *Tephrosiae* Beeli.
Neocospospora vasinfecta E. F. Sm.
Gibberella sp.
Cylindrosporium Tephrosiae Hansford.
Fusarium spp.
Camptomeris Tephrosiae Hansford.
Rhizoctonia bataticola (Taub.) Butl.
Uredo sp.
TERAMNUS sp.
Meliola bicornis Wint.
TRIFOLIUM sp.
Polythrincium Trifolii Kunze.
VICIA sp.
Uromyces Fabae (Pers.) De Bary.
Erysiphe Polygoni DC. in *Oidium* stage.
Cladosporium album Dowson (conidia of *Erostrotheca multiformis*.
VIGNA sp.
Woroninella Dolichi (Cooke) Syd.
Woroninella sp. nov.
Erysiphe Polygoni DC. in *Oidium* stage.
Parodiella perisporioides (B. & C.) Speg.
Mycosphaerella pinodes (B. & Br.) Vesterg.
Phyllachora sp.
Uromyces Vignae Barclay.
Aecidium Vignae Cooke.
Ascochyta phaseolorum Sacc.
Colletotrichum lindemuthianum (Sacc. & Magn.) Br. & Cav.
Cladosporium Vignae Gard. (?)
Cladosporium album Dowson.
Cercospora cruenta Sacc.
Alternaria sp.
Macrophomina Phaseoli (Maubl.) Ashby.
VOANDZEIA sp.
Cercospora canescens Ell. & Ev., f.
Macrophomina Phaseoli (Maubl.) Ashby.
ZORNIA sp.
Puccinia Zorniae McAlpine.

MYRICACEAE

MYRICA sp.
Dothidina disciformis Theiss. & Syd.
Irenina manca (Ell. & Mart.) Stev.
(*Meliola Myricae* Hansford, Kivu, Congo).
Cercospora sp.

CASUARINACEAE

CASUARINA sp.
Rhizoctonia lamellifera Small.

ULMACEAE

CHAETACHME sp.
Meliola Chaetachmes Hansford.
TREMA sp.
Irenina Tremae (Speg.) Stevens.
Asterina Sponiae Rac.
Oothecium stylosporum (Cooke) Doidge.
Englerula sp. (?)

MORACEAE

ANTIARIS sp.
Elsinoe Antiaridis Hansford.
Irenina Fici Hansford.
Cercosporella Antiaridis Hansford.
ARTOCARPUS sp.
Rhizoctonia lamellifera Small.
BOSQUIEA sp.
Meliola Soroceae Speg.
Phaseosaccardinula Bosquieae Hansford.
CHLOROPHORA sp.
Meliola Chlorophorae Hansford.
Asterina Chlorophorae Hansford.
Capnodium sp.
FICUS sp.
Irene ugandensis Hansford.
Irenina Fici Hansford.
Irenina obesa (Speg.) Stevens.
Meliola ficium Yates.
Diplochorella Fici Hansford.
Mycosphaerella Fici-ovatae Hansford.
Phyllachora amaniensis P. Henn.
Phyllachora Dawei Massee.
Phyllachora Elmeri (Syd.).
Phyllachora repens Cooke.
Phyllachora ulcerata Massee.
Kuehneola Fici Butl.

Uredo sp., *Hansford 3051.*
Armillaria mellea (Vahl) Fries.
Colletotrichum sp.
Capnodium sp.
Pestalozzia sp.
Cercospora ficina Tharp.
Cercospora Fici Heald & Wolf.
Triposporium sp.
Microzyphium sp.

MORUS sp.
Mycosphaerella moricola (Fckl.) Lindau.
Septobasidium sp.
Septogloeum Mori (Lev.) Br. & Cav.

MYRIANTHUS sp.
Balladynella Myrianthi Hansford.

URTICACEAE

BOEHMERIA sp.
Ascochyta Boehmeriae Woron.
Colletotrichum Boehmeriae K. Saw.
Cercospora Boehmeriae Peck.

URERA sp.
Elsinoe Urerae Hansford.

CANNABINACEAE

CANNABIS SATIVA
Cercospora cannabina Wakef.

CELASTRACEAE

GYMNOSPORIA sp.
Parenglerula Macowaniana (Thum.) V. Hoehnel.
Irenopsis Gymnosporiae Hansford.
Clypeolella Gymnosporiae Hansford.
Pestalozzia Celastri Tassi.

ICACINACEAE

RHAPHIOSTYLIS sp.
Micropeltis Ugandae Hansford.

OLACACEAE

OLAX sp.
Irene Strombosiae Hansford.

LORANTHACEAE

LORANTHUS sp.
Meliola Loranthi Gaill.
Asterinella sp.
Aecidium cookeanum De Toni.
Septobasidium sp.

VISCUM sp.
Aecidium cookeanum De Toni.

RHAMNACEAE

GOUANIA sp.
Irenopsis tenuissima (Stev.) Stev.
Puccinia Gouaniae Holw.

RHAMNUS sp.
Aecidium sp.

SCUTIA sp.
Irenopsis Scutiae Hansford.
Lembosia holomela Syd.
Elsinoe Hansfordii Bitanc & Jank.

VENTILAGO sp.
Meliola Ventilaginis Hansford.
Chaetothyrium sp.
Micropeltis Ugandae Hansford.
Micropeltis spiralis Hansford.
Clypeolum scutelliforme Rehm.
Eremotheca philippinensis Syd.
Actinopeltis Funtumiae Hansford.
Phaeosaccardinula Canthii (Hansf.) Hansford.
Argyriopsis javanica v. Hoehnel.

ZIZYPHUS sp.
Schiffnerula sp.
Mitteriella zizyphina Hansford.
Coniodictyum Chevalieri Har. & Pat.

VITACEAE

CISSUS sp.
Plasmopara viticola (B. & C.) Berl. & De Toni.
Elsinoe sp.
Meliola Cissi Hansford.
Dimeriella Cissi Hansford.
Uredo sp.
Aecidium vitis A. L. Sm.
Mycosyrinx Cissi (DC) Beck.

LEEA GUINEENSIS
Irenopsis Leeae Hansf. & Stev.
Phyllachora Leeae Koord.

RHOICISSUS sp.
Schiffnerula sp.
Meliola Merrillii Syd.

VITIS VINIFERA
Plasmopara viticola (B. & C.) Berl. & De Toni.
Uncinula necator (Schw.) Burr.

Indet. Hosts
Asterina sp.
Meliola Bakeri Syd.

RUTACEAE

AEGLE MARMELOS
Oidium tingitanianum Carter.

BALSAMOCITRUS sp.
Dictyopeltis consimilis Syd.

CITRUS spp.
Elsinoe Fawcetti Bitanc. & Jenkins.
Chaetomium trigonosporum (March.) Chivers.
Gloermerella cingulata (Stonem.) Spauld. & Schrenk.
Penicillium glaucum Link.
Penicillium italicum Wehm.
Nematospora Coryli Pegl.
Sphaceloma Fawcetti Jenkins.
Colletotrichum gloeosporioides Penz.
Diplodia natalensis Evans.
Cladosporium Citri Massee.
Alternaria Citri Pierce.
Rhizoctonia lamellifera Small.

CLAUSENA sp.
Asterina clausenicola Doidge.

FAGARA sp.
Meliola Fagarae Hansford.
Asterostomella sp.

TECLEA NOBILIS
Meliola Tecleae Hansford.
Halbaniella Tecleae Hansford.
Puccinia Tecleae Pass.

TODDALIA ACULEATA
Schiffnerula Toddaliae Hansford.
Meliola Tecleae Hansf., var. *Toddaliae-asiaticae* Hansford.
Asterina sp.
Ctenoderma Toddaliae (Petch) Syd.

SIMARUBACEAE

HARRISONIA sp.
Meliola Harrisoniae Hansford.
Cercospora Harrisoniae Hansford.

MELIACEAE

CARAPA sp.
Cocconia concentrica Syd.

CEDRELA TOONA
Capnodium brasiliense Putt (?).

ENTANDROPHRAGMA sp.
Meliola bersamicola Hansford.
Meliola bunyorensis Hansford.
Meliola geniculata Syd. & Butl., var. *Eggelingii* Hansford.
Irenina glabroides (Stev.) Stevens.
Uredo sp.

EKEBERGIA sp.
Meliola Ekebergiae Hansford.
Asterina sp.

KHAYA ANTOTHECA
Meliola Khayae Hansford.
Phyllosticta sp.

LOVOA sp.
Irenina glabroides (Stev.) Stevens.
Elsinoe sp.

TRICHILIA sp.
Irenina glabroides (Stev.) Stevens.
Meliola Chorleyi Hansford.
Meliola opposita Syd.
Meliola Thomasii Hansford.
Cocconia concentrica Syd.
Clypeolum scutelliforma Rehm.
Micropeltis Ugandae Hansford.
Eremotheca philippinensis Syd.

TURRAEA sp.
Meliola Nephelii Sacc. var. *major* Hansf. & Stev.
Asterina ugandensis Syd.

SPINDACEAE

ALLOPHYLLUS sp.
Schiffnerula Allophylli Hansford.
Meliola furcillata Doidge.
Meliola Nephelii Sacc. var. *major* Hansford & Stevens.
Stomiopeltis Allophylli Hansford.
Mycosphaerella conferta (Speg.) Wakef.
CARDIOSPERMUM sp.
Meliola Cardiospermi Hansford & Stevens.
DEINBOLLIA sp.
Meliola Deinbolliae Hansford.
PAULLINIA PINNATA
Meliola Paulliniae Stev.
Halbaniella Paulliniae Hansford.
PHIALODISCUS sp.
Meliola Thomasii Hansford.

MELIANTHACEAE

BERSAMA sp.
Meliola Bersamae Hansford.
Meliola bersamicola Hansford.
Irenina Bersamae Hansford.
Asterina Trichiliae Doidge (=*Englerulaster Bersamae* Hansf. ined.).
Cocconia concentrica Syd. (=*Cycloschizon Bersamae* Hansf. ined.).
Physalospora Bersamae Syd.
Scolecopeltis Bakeri Syd.
Micropeltis Ugandae Hansford.
Meliola Chorleyi Hansford.
Lembosina sp. (?)

ANACARDIACEAE

ANACARDIUM sp.
Limacinia Anacardii Hansford.
Pestalozzia palmarum Cooke (?)
Teratosperma Anacardii Hansford.
MANGIFERA INDICA
Erysiphe cichoracearum DC.
Glomerella cingulata (Stonem.) Spauld. & Schrenk.
Armillaria mellea (Vahl) Fries.
Colletotrichum sp.
Periconia sp.
Cercospora Mangiferae Koord.
PSEUDOSPONDIAS sp.
Elsinoe ugandensis Hansford.
Lembosia microcarpae Hansford.
Micropeltis corynespora Sacc.
Dictyopeltis entebbeensis Hansford.
Scolecopeltis Bakeri Syd.
RHUS spp.
Melliola Rhois P. Henn.
Meliola Rhois P. Henn. var. *minor* Hansford.
Meliola Dummeri Hansford.
Meliola Weigeltii Kunze.
Schiffnerula sp.
Exobasidium hesperidum Maire.

CONNARACEAE

AGELAEA sp.
Englerulella minima Hansford.
Meliola Agelaeae Stev. & Roldan.
Meliola agelaeicola Hansford.
Meliola mabirensis Hansford.
Oomyces sp.
Micropeltis Ugandae Hansford.
Eremothecella ugandensis Hansford.
JAUNDAEA. sp.
Meliola Agelaeae Stev. & Roldan.

ARALIACEAE

PANAX sp.
Rhizoctonia lamellifera Small.
Rosellinia bothrina (B. & Br.) Sacc.
POLYSCIAS FULVA
Acanthostigma trichophila (Syd.) Hansford.
Lachnum trichophilum Syd.
Cercosporella Polysciatis (P. Henn.) Hansford (=*Helminthosporium fulvae* Hansf., ined.).

UMBELLIFERAE

ANETHUM GRAVEOLENS
Cercospora anethi Sacc.
HETEROMORPHA sp.
Aecidium Heteromorphae A. L. Sm.
HYDROCOTYLE sp.
Septoria nesodes Kalchbr.
PEUCEDANUM sp.
Uredo sp. (? of *Uromyces Fiorianus* Sacc.).

ERICACEAE

ERICA ARBOREA
Dimerosporium Elliotii A. L. Sm.
Dimerosporiopsis Englerianum P. Henn.

VACCINIACEAE

VACCINIUM STANLEYI
(*Irene Vaccinii* Hansford, Kivu, Congo).

EBENACEAE

EUCLEA sp.
Meliola Eucleae Hansford.

SPOTACEAE

BUTYROSPERMUM PARKII
Cercospora Butryospermi Hansford.
MIMUSOPS sp.
Meliola Snowdeni Hansford & Stevens.
SERSALISIA sp.
Asterina robusta Doidge.

MYRSINACEAE

MAESA LANCEOLATA
Amazonia peregrina Syd.
Meliola Groteana Syd.
Meliola maesicola Hansford & Stevens.
Dimeriella Maesae Hansford.
Physalospora chaenostoma Sacc.
Cercospora Maesae Hansford.

LOGANIACEAE

ANTHOCLEISTA sp.
Coccodothella trachylaena Syd.
BUDDLEIA sp.
Rhizoctonia lamellifera Small.

OLEACEAE

JASMINUM spp.
Schiffnerula sp.
Meliola Jasmini Hansf. & Stev.
Meliola busogensis Hansford.
Meliola Daviesii Hansford.
Meliola gemellipoda Doidge.
Asterina erysiphoides Kalchbr. & Cooke.
Chaetothyrium guaraniticum Speg.
Chaetothyrium sp.
Phaeosaccardinula Jasmini Hansford.
Calonectria Jasmini Hansford.
Hemileia Hansfordii Syd.
Uromyces Hobsoni Vize.
OLEA CHRYSOPHYLLA
Capnodiastrum sp. (probably conidia of *Asterodothis solaris* [Kalchbr. & Cooke] Theiss. & Syd.).

APOCYNACEAE

ALAFIA sp.
Cercosporella Alafiae Hansford.
CARISSA sp.
Meliola Carissae Doidge.
Lembosia sp.
CONOPHARYNGIA sp.
Puccinia Tabernaemontanae B. & Br.
FUNTUMIA sp.
Meliola Funtumiae Belli.
Meliola reflexa Hansford.
Actinopeltis Funtumiae Hansford.
Asterina Funtumiae Syd.
Microthyriella gigantospora Hansford.
Micropeltella macrospora Hansford.
Micropeltella Funtumiae Hansford.
Scolecopeltis Funtumiae Hansford.
Micropeltis Ugandae Hansford.
Septobasidium sp.

LANDOLPHIA sp.
Penicillopsis Dybowskii Pat.
Meliola Landolphiae Hansford.
Meliola Landolphiae-floridae Hansford.
Micropeltella Maitlandii Hansford.
Scolecopeltis Bakeri Syd.
Asterostomella sp.
Phaeosaccardinula javanicum (Zimm.) Yamamoto.
Mircoxyphium sp.
MOTANDRA sp.
Meliola Landolphiae Hansford.
Meliola Motandrae Hansford.
Asterina blanda Syd.
Asterina aulica Syd.
ONCINOTIS sp.
Meliola Motandrae Hansford.
Asterina aulica Syd.
STROPHANTHUS spp.
Hemileia Strophanthi Rac. on *S. hispidus*.
Hemileia Smallii Hansford (ined.) on *S. Courmontii*.
Microthyriella gigantospora Hansford.
Meliola Strophanthi Hansford.
VOACANGA sp.
Meliola Voacangae Hansford & Stevens.
Colletotrichum sp.
Indet. Hosts
Asterina sp.
Meliola bidentata Cooke.
Meliola intermedia Gaill.
Meliola reflexa Hansford.

ASCLEPIADACEAE

ASCLEPIAS sp.
Rhizopus nigricans Ehrenb.
PERGULARIA sp.
Uredo sp.
Meliola euopla Syd.
SECAMONE sp.
Uromyces Secamones Wakef.
Hemileia Secamones Hansford, ined.
Asterina sp.
TYLOPHORA sp.
Meliola euopla Syd.
Elsinoe Tylophorae Hansford.
Helminthosporium Tylophorae Hansford.

RUBIACEAE

BORRERIA sp.
Puccinia lateritia B. & C.
CANTHIUM spp.
Meliola Woodiana Sacc. (?)
Balladyna magnifica (Syd.) Hansford.
Balladyna tenue Hansford.
Balladynstrum entebbeensis Hansford.
Chaetothyrium sp.
Phaeosaccardinula Canthii (Hansf.) Hansford.
Oomyces javanicus v. Hoehnel.
Asterina aterrima Syd.
Micropeltis spiralis Hansford.
Micropeltis Ugandae Hansford.
Micropeltella Maitlandii Hansford.
Microthyriella gigantospora Hansford.
Dictyopeltis entebbeensis Hansford.
Eremotheca philippinensis Syd.
Systremma Canthii Hansford.
Aecidium Plectroniae Cooke.
CEPHAELIS sp.
Meliola Smallii Hansf. & Stev.
CINCHONA sp.
Cercospora Cinchonae Ell. & Ev.
Rhizoctonia lamellifera Small.
COFFEA ARABICA
Nematospora Coryli Pegl.
Capnodium brasiliense Putt. (?)
Glomerella coffeicola Averna-Sacca (?).
Hemileia vastatrix B. & Br.
Polyporus Coffeae Wakef.
Armillaria mellea (Vahl Fries.
Colletotrichum sp.
Cercospora coffeicola B. & C.
Rhizoctonia Solani Kuhn.
Rhizoctonia bataticola (Taub.) Butl.
Rhizoctonia lamellifera Small.
Rhizophagus sp.
Fusarium diversisporum Sherb.
Fusarium sporotrichioides Sherb.
Phoma sp.
Phomopsis sp.
Gnomonia sp.
Coniothyrium sp.
Hendersonia (*coffeae* Delacr. ?).
Septoria Coffeae Wakef.
Stilbellæ spp.
COFFEA EUGENIOIDES
Hemileia vastatrix B. & Br.
Asterolibertia Burchelliae Doidge.
COFFEA EXCELSA
Hemileia vastatrix B. & Br.
Alternaria sp. (?)
COFFEA LIBERICA
Hemileia vastatrix B. & Br.
COFFEA ROBUSTA
Nematospora Coryli Pegl.
Irenina glabra (B. & C.) Stevens.
Meliola Coffeae Hansford.
Capnodium (*brasiliense* Putt. ?).
Glomerella (*Coffeae* Averna-Sacca).
Hemileia vastatrix B. & Br.
Polyporus Coffeae Wakef.
Armillaria mellea (Vahl) Fries.
Colletotrichum spp.
Pestalozzia sp.
Cercospora coffeicola B. & C.
Rhizoctonia Solani Kyhn.
Rhizoctonia bataticola (Taub.) Butl.
Rhizoctonia lamellifera Small.
Rhizophagus sp.
CRATERISPERMUM sp.
Meliola vicina Syd.
Balladynastrum entebbeensis Hansford.
LEPTACTINIA sp.
Balladyna tenuis Hansford.
MITRACARPUM sp.
Aecidium Mitracarpi Syd.
Balladyna sp.
MITRAGYNA sp.
Meliola (*woodiana* Sacc. ?).
MORELIA sp.
Meliola Duggenae Stev. var. *major* Hansford.
MUSSAENDA sp.
Balladynastrum entebbeensis Hansford.
OLDENLANDIA sp.
Meliola Oldenlandiae Hansford & Stevens.
Puccinia Oldenlandiae P. Henn.
Cercospora Oldenlandiae Hansford.
OXYANTHUS spp.
Meliola Mitchellae Cooke.
Asterina aterrima Syd.
Hemileia Oxyanthi Cummins.
Micropeltis Ugandae Hansford.
PAVETTA sp.
Balladyna ugandensis (Syd.) Hansford.
Balladyna velutina (B. & C.) v. Hoehnel.
Balladynastrum glabra Hansford.
Amazonia asterinoides (Wint.) Theiss.
Meliola Mitchellae Cooke.
Clypeolella ugandensis Hansford.
Hariotula Pavettae Hansford.
Hemileia Mildbraedii Syd.
Aecidium flavidum B. & Br.
Micropeltella Maitlandii Hansford.
PENTANISIA sp.
Puccinia Pentanisiae Cooke.
PENTAS sp.
Meliola Psychotriae Earle.
Puccinia pentadicola Grove.
Puccinia Pentadis-carneae Wakef.
PSYCHOTRIA sp.
Meliola longiseta v. Hoehnel.
Meliola Mitchellae Cooke var. *longiseta* Hansford.
Balladyna sp.
Hemileia Holstii Syd.
RANDIA sp.
Meliola Mitchellae Cooke var. *longiseta* Hansford.

RUBIA sp.
Puccinia dimorpha Syd.
Puccinia rubiicola Syd.
RUTIDEA sp.
Balladyna ugandensis Syd.
Balladynastrum glabra Hansford.
Hemileia sp.
Aecidium sp.
TRICALYSIA sp.
Meliola sp.
Asterolibertia megathria Doidge.
UNCARIA sp.
Micropeltis Ugandae Hansf.
VANGUERIA sp.
Hemileia Woodii Kalchbr. & Cooke.
Aecidium Vangueriae Cooke.
Cercospora sp.
Indet. Hosts
Balladyna ugandensis (Syd.) Hansf.
Balladynastrum entebbeensis Hansford.
Balladynastrum glabra Hansford.
Balladyna Deightoni Hansford.
Balladyna velutina (B. & C.) v. Hoehne[1].
Amazonia asterinoides (Wint.) Theiss.
Meliola Kibirae Hansf. & Stevens.
Meliola Smallii Hansf. & Stevens.
Meliola (*Woodiana* Sacc. ?).
Meliola Woodiana Sacc. var. *aristata* Hansford.
Dimeriella Hansfordii (Syd.) Hansford.
Micropeltis corynespora Sacc.
Eremotheca philippinensis Syd.
Asterolibertia megathyria Doidge.
Scolecopeltis sp.
Oomyces javanicus v. Hoehnel.

COMPOSITAE

AGERATUM sp.
Heptameria obesa (Dur. & Mont.) Sacc.
Aecidium Agerati P. Henn.
Cladosporium herbarum Lk., f.
ASPILIA sp.
Uromyces Aspiliae Wakef. & Hansf. (ined.).
BERKHEYA SPEKEANA
Puccinia Berkheyae Wakef.
BIDENS sp.
Olpidium Brassicae (Wor.) Dang.
Uromyces Bidentis Lagerh.
Entyloma Bidentis P. Henn.
Periconia sp.
Rhizophagus sp.
Cercospora megalopotamica Speg.
BLUMEA sp.
Aecidium Blumeae P. Henn.
CARDUUS sp.
Puccinia Cnici-oleracei Pers.
Puccinia sp.
CHRYSANTHEMUM sp.
Pythium ultimum Trow.
Olpidium Brassicae (Wor.) Dang.
COREOPSIS sp.
Puccinia Coreopsidis Wakef.
Uredo sp. on *C. Grantii.*
Irenina cyclopoda (Stev.) Stevens.
Irenina glabra (B. & C.) Stevens.
CONYZA sp.
Aecidium Macowanianum Thum.
COSMOS BIPINNATUS
Oidium sp.
DAHLIA sp.
Entyloma Dahliae Syd.
Rhizoctonia bataticola (Taub.) Butl.
DAUCUS CAROTA
Bacterium carorovorus.
DICHROCEPHALA sp.
Aecidium Dichrocephalae P. Henn.
ECHINOPS sp.
Puccinia pulvinata Rabh.
EMILIA sp.
Plasmopara Halstedii (Farl.) Berl. & De Toni.
ERLANGEA sp.
Dimeriella claviseta Doidge.
Schiffnerula compositarum (Theiss.) Petr.
Puccinia Erlangeae Grove.
GAZANIA sp.
Sclerotium Rolfsii Sacc.
GERBERA JAMESONII
Septoria Gerberae Syd.
Rhizoctonia bataticola (Taub.) Butl.
GUIZOTIA sp.
Rhizoctonia bataticola (Taub.) Butl.
GYNURA sp.
Aecidium Gynurae Wakef. & Hansf., ined.
HELIANTHUS ANNUUS
Helminthosporium Helianthi Hansford.
Alternaria tenuis Bolle.
Rhizoctonia bataticola (Taub.) Butl.
Cercospora pachypus Ell. & Kell.
Sclerotium Rolfsii Sacc.
HELICHRYSUM sp.
Puccinia Kalchbrenneri De Toni.
Isariopsis Helichrysi Hansford.
INULA sp.
Uredo sp. (of *Puccinia Kalchbrenneri* De Toni ?).
LACTUCA sp.
Bremia Lactucae Regel.
Puccinia Lactucae-capensi Wakef. & Hansf., ined.
Aecidium sp.
Septoria Lactucae Pass.
Cercospora longissima (Cugn.) Sacc.
MELANTHERA sp.
Uromyces Melantherae Cooke.
MICROGLOSSA sp.
Irenina cyclopoda (Stev.) Stev.
Puccinia aurata Syd.
Aecidium Microglossae Petch.
MIKANIA sp.
Elsinoe Chandleri Hansford.
Dimeriella claviseta Doidge.
SENECIO sp.
Aecidium Senecionis-bipleuroidis Syd.
Aecidium sp.
Plasmopara Halstedii (Farl.) Berl. & De Toni.
Cercospora sp.
SONCHUS sp.
Bremia Lactucae Regel.
Puccinia Sonchi Rob.
Rhinotrichum Sonchi Hansford.
Alternaria Sonchi Davis apud Elliott.
SPILANTHES sp.
Puccinia africana Cooke.
TAGETES sp.
Cercospora sp.
VERNONIA spp.
Dimeriella claviseta Doidge.
Irenia glabra (B. & C.) Stev.
Mycosphaerella Dummeri Hansford.
Ophiobolus Butleri Syd., prox.
Puccinia Hansfordii Wakef., ined.
Puccinia Le Testui Maubl.
Puccinia vernoniicola P. Henn.
Aecidium Vanderystianum P. Henn.
Uredo Vernoniae P. Henn.
Melampsora Junodii Doidge.
Schiffnerula Compositarum (Theiss.) Petr.
Irenina cyclopoda (Stev.) Stevens.
Tryblidiella rufula (Spreng.) Sacc.
Cladosporium herbarum Lk., f.
Cercosporum sublateritia P. Henn.
WEDELIA sg.
Irenina glabra (B. & C.) Stev.
Puccinia Melampodii Diet. & Holw.
ZINNIA ELEGANS
Oidium sp. (? *Erysiphe cichoracearum* DC.).
Cercospora atrocincta Heald & Wolf.

PLUMBAGINACEAE

PLUMBAGO sp.
Meliola Plumbaginis Hansf. & Stevens.

PLANTAGINACEAE

PLANTAGO sp.
Meliola Plantaginis Hansf. & Stev.

(*To be Continued.*)

NOTES ON ANIMAL DISEASES

Compiled by the Veterinary Department, Kabete, Kenya

XIX—MASTITIS IN CATTLE

Mastitis or mammitis is the general name applied to inflammation of the udder and it must be realized that the name does not indicate any specific condition. Most forms of mastitis are difficult to control and the condition is responsible for great losses every year in all dairying countries.

Cause.—Mastitis may originate in a number of ways, the most frequent being probably:—

(*a*) Localization of germs in the udder following septicæmia caused by retained afterbirth and septic metritis. In cases of acute mastitis in England, this is one of the most important factors.

(*b*) Local penetration of bacteria into the gland either via the teat duct (e.g. when a dirty teat-siphon is used) or via the skin (e.g. when the skin of the udder is torn by barbed wire and a dirty wound results).

(*c*) Contagion (e.g. chronic contagious streptococcal mastitis, which is believed to spread from cow to cow on the hands of the milker, and cases of tuberculous mastitis which may arise during an outbreak of tuberculosis in a herd).

In addition, bad methods of drying-off, changes in food and chills are often blamed as originating factors in cases of acute infection.

When viewed from another angle, the forms of mastitis can be classified according to the types of bacteria present in the udder. We can thus recognize two specific types:

(*a*) tuberculous mastitis,

(*b*) chronic streptococcal mastitis due to *Streptococcus agalactiae*,

and various non-specific types caused by streptococci, staphylococci, *Corynebacterium pyogenes*, etc.

Mastitis is more prevalent in high-producing animals. It is reasonable to believe that when a cow becomes a milk-producing machine and no attention is paid to stamina, susceptibility to udder trouble will be increased.

Symptoms.—In acute mastitis it is usual to find more than one quarter of the udder infected. The affected part is swollen, hot and painful, and on drawing the teat a small quantity of serous fluid, clotted material or pus may be obtained. Many cases, if left untreated, go on to gangrene, particularly when *Corynebacterium pyogenes* is present.

In chronic cases there is usually at the outset some hardening of the affected quarter before the milk is visibly affected. In tuberculous mastitis, before the character of the secretion becomes altered, this induration may be extensive. In chronic streptococcal mastitis the reduced quantity of milk secreted by the quarter may be the only evidence that there are disease changes present and infection can be confirmed only by chemical or bacteriological tests.

In addition to local symptoms, general symptoms are usually present in severe cases of acute mastitis. Examples of these are fever, lack of appetite, and, in the later stages, signs of toxæmia or septicæmia. In tuberculous mastitis the cow usually shows other evidence of being infected with tuberculosis. There may be a cough, if pulmonary infection is present, and there is nearly always emaciation. Tuberculosis is, of course, a rather rare disease in Kenya and only one or two cases of tuberculosis of the udder have been recorded.

It should be mentioned that when milking machines are run with too great a vacuum certain cows develop some hardening of the udder. In such cases the nature of the milk secretion is not affected, and bacteriological examination will show the absence of any infective process.

Except when gangrenous or tuberculous mastitis is present, it is unusual for death to supervene; but it is only too common for one or more of the affected quarters to go blind.

Diagnosis.—In acute cases diagnosis presents little difficulty, but in chronic streptococcal mastitis it is frequently impossible to decide from a clinical examination whether a quarter is affected or not. Various attempts have been made to devise rapid methods of diagnosis. For example, a large number of cases can be detected by determining the alkalinity of the milk. A jet of milk from the udder is used to wet a piece of paper impregnated with the dye, brom-cresol-purple. If the milk is abnormal the colour of the paper changes from yellow to purple. Such tests, however, fail to detect a number of positive cases and

on the other hand give a number of false positive results.

The only certain method of making a diagnosis is by the bacteriological examination of a sample of milk. Where the farm is situated close to the laboratory this is a relatively simple matter. As every dairyman knows, however, it is far from easy to obtain a clean sample of milk, and if examination is delayed, milk being an excellent culture medium, the presence of pathogenic bacteria may be concealed by the rapid multiplication of milk-souring and other extraneous organisms.

Before collecting a sample, a small bottle and cork should be sterilized by boiling. The teat of the suspected quarter should then be washed with clean water containing disinfectant, and excess moisture should be removed with a clean cloth that has been soaked in the disinfectant solution, and then wrung out. Two or three pulls should be given at the teat to flush out the canal and then the bottle should be filled direct from the jet. Care should be taken that the cork is not contaminated whilst the bottle is being filled. The bottle should be despatched at once to the laboratory with a letter giving details of the case.

The cultivation and identification of organisms from milk occupy several days, and a report, therefore, cannot be sent off immediately the specimen is received.

Treatment.—Acute cases should be milked out every two hours, the discharge being collected in a tin containing a strong disinfectant solution and buried. Hot fomentations are useful to ease the pain in the udder and promote the discharge of harmful fluid. In valuable animals with acute streptococcal infection, sulphonamides, such as sulphonamide-P and soluseptasine may be given, or a dose of salts, followed by the usual veterinary febrifuges, may be helpful. If necrosis of the teat occurs the assistance of a veterinary surgeon to remove the teat is advisable.

In many chronic cases, if treatment is begun during the early stages, the injection into the udder, via the teat, of drugs of the acridine series has proved of great value. The two most successful are acriflavine in a dilution 1/10,000 and entozon 1/1,250. The former is to be preferred since it does not cause quite so much disturbance in the udder.

In preparing the solution, about 1 litre or $1\frac{3}{4}$ pints should be allowed for each quarter to be treated. The correct amount of the drug is dissolved in boiling water and the solution allowed to cool to blood heat. At the same time a simple rubber enema-pump, with a teat-siphon attached, is placed in a pan of water and brought to the boil in order to sterilize it.

The udder and teats are washed thoroughly with a warm disinfectant solution and the udder is stripped. The teat-siphon is then inserted into the quarter to be treated and about 3 oz. of the prepared solution at blood heat are injected. The quarter is massaged and the solution stripped out immediately. The siphon is again inserted and, this time, as much solution is injected as will distend the quarter to its normal size previous to milking.

Leave in for 7 to 10 minutes, the longer period if clinical changes are present in the quarter. Massage lightly during this period. Strip out completely and strip out again twice that day. Strip out three or four times on the following day and repeat treatment a week later.

In dry cows the injection may be left in for 24 hours.

For a few days after injection the milk may be discoloured and contain clots, but by the end of a week these temporary effects should have disappeared.

Cases of mastitis should, when possible, be milked in a separate shed, and when this is impossible should be brought into the byre and milked after the other cows have been turned out.

In certain instances it would appear that vaccines are helpful in the treatment of chronic mastitis. The vaccine used should be an autogenous vaccine, that is, prepared from organisms isolated from the actual case. Vaccine will be prepared from samples sent in for diagnosis if the owner wishes, and if a bacteriological examination suggests that vaccine treatment will prove useful.

Cases of tuberculous mastitis must, of course, be destroyed.

Public Health.—Much research work has been devoted to the study of the public health aspect of mastitis. Milk that is obviously abnormal in appearance should, of course, never be mixed with bulk supplies for human consumption.

In the case of apparently normal milk from infected quarters, in the vast majority of cases it has been shown that the bacteria present, usually streptococci, are not types likely to cause sore throat or other human diseases. It is, however, obviously undesirable to sell such milk, and it is, therefore, recommended that it be pasteurized and fed to calves.

REVIEWS

C. GILLMAN—WATER CONSULTANT'S REPORT NO. 6, 1940—A RECONNAISSANCE SURVEY OF THE HYDROLOGY OF TANGANYIKA TERRITORY IN ITS GEOGRAPHICAL SETTINGS.

Lack of recognition of the importance of water supplies has been in the past a feature of the government of native communities in many parts of the world; this omission, however, is now being rectified almost everywhere. When we consider how much this want of perspective has cost East African native populations in time, health and deterioration of the land, to mention but three results, we appreciate the need for a complete hydrological survey of every country after the manner of Mr. Gillman's review of conditions in Tanganyika.

The Tanganyika Government are to be congratulated upon their acumen in taking advantage of Mr. Gillman's wide contacts to deal with hydrological problems of the Territory. This officer has had many years of experience as Chief Engineer to the Tanganyika Railways and has been a keen observer of all geographical aspects that go to the making of the Tanganyika scene; as a result of his observations he has been able to subscribe both previous reports on regional surveys of the hydrology of the country and a series of papers on a wide range of geographical subjects. His latest paper is a general and final review of the factors that go to the making of the country's water resources, and is intended as a basis for study by those who will have to take up the task of supplying and conserving the Territory's water supplies in the years to come.

Mr. Gillman considers firstly the drainage system of Tanganyika and subsequently meteorological factors, vegetation, and the influence of man on the vegetation and water resources; he ends up by outlining suggestions for the study and improvement of supply and conservation. He does not pretend to do more than sketch possible methods of attacking these problems and it is for others who have the training and necessary experience to attend to this. The report, representing as as it does mainly the record of a lifetime's experience of a keen and capable observer, therefore disarms major criticism, and such faults as may be indicated relate entirely to points of detail which do not in any way alter the general thesis. It is to be hoped that the Tanganyika Government, having made such a good start, will see that the many years of hard work and keen observation represented by this report are put to full use.

It will undoubtedly be best, in the opinion of the reviewer, to consider this problem of water supply and conservation in years to come as an East African one. A great deal of information on certain aspects of amelioration will be available after the war from the work carried out in Kenya and Uganda which should be put to the benefit of East Africa as a whole. It will then be realized that the time and money spent in such surveys as those carried out by Mr. Gillman are investments of the highest value. K. A. DAVIES.

GRASS BURNING

A recently published article (*Emp. Jnl. of Exp. Agr.*, Oct. 1942, pp. 219–231) on the contentious subject of "Grass Burning" is of exceptional interest to East African readers. The writer is D. C. Edwards, Senior Agricultural Officer (Pasture Research) of the Kenya Agricultural Department. He gives an account of certain grass burning experiments planned by him and carried out on the Veterinary Stock Farm at Ngong.

The experiment was designed to study the effect of the following treatments: (*a*) burning alone; (*b*) burning and light grazing; (*c*) light grazing; (*d*) medium grazing; (*e*) heavy grazing; and (*f*) complete protection from both burning and grazing. It was started in 1931 and seems to have had a somewhat chequered career as the treatments were discontinued in 1935, except for the protection from grazing and burning. This seems a pity as an experiment such as this has considerable (and much-needed) educational value even after it has outlived its usefulness as a scientific investigation. In 1939, as the result of an accidental fire sweeping through the Veterinary Farm, which we are told had adopted a policy of non-burning in the management of its pastures, a portion of the experimental area was burned off.

In the grassland investigated two species are given as of major importance: *Themeda triandra*, the Red Oat Grass so frequently found dominant in African grasslands; and *Digitaria abyssinica*, the much-hated couch-grass ("Sangala") of East African coffee plantations. In all plots at the commencement of the experiment the former was the dominant species and far more prevalent than the latter.

Only the 1941 data on the botanical composition of the herbage is given, and although only single plots were used, the differences in regard to the major changes are so great as to seem reliably significant. The effect of non-burning completely reversed the relative prevalence of the Red Oat Grass and the couch-grass with apparently an adverse effect on both the quality and quantity of the grazing. This latter point, however, seems to me to require further investigation. Over-grazing for five years, at the rather excessive rate of stocking of 728 ox-days per acre per annum, was also found to discourage the Red Oat Grass and encouraged the couch-grass.

Samples were taken of the top three inches of soil and partial analyses made. The differences are hardly big enough to be significant, but they do tend to indicate that a higher humus content was being built up as the result of non-burning. One should not forget, too, that ten years is a comparatively short period in soil formation.

The damage to the soil is the argument perhaps most usually advanced against burning, an argument which to the average mind seems irrefutable. Yet how often do conclusions based entirely on theory eventually prove incorrect? In a ten years' study in the U.S.A. it was found (to quote) "that soil organic matter is maintained at a higher level in grasslands frequently burnt over—a finding which is in direct opposition to the common view". The authors of this study did, however, find that the physical properties of the soil were adversely affected by burning, although the chemical properties were improved! In Europe, too, a recent report on an investigation dealing partly with burning mentions that increased yields were obtained from meadow land as the result of burning. (*Herb. Abstr.* No. 976, Oct. 1942.) However, the prairies of America or the meadows of Europe are not the grasslands of East Africa, and before definite information is available on this point a great deal more sound experimentation will be necessary.

The author also discusses at some length the vegetation changes which took place and refers to similar results obtained with Red Oat Grass in a study carried out in Natal, South Africa, which incidentally was the first experiment to be started on grass burning in Africa, if not in the world. It may be mentioned, too, that an experiment in the Southern Highlands of Tanganyika, laid down in 1931, Red Oat Grass has largely disappeared from the burnt plots (Staples, *Ann. Rep. of Dept. of Vet. Sci. and An. Husb.*, T.T. (1937)). On the other hand, under more arid conditions in South Africa, burning has been found to discourage the prevalence of this species.

The non-burning for ten years apparently had only a minor effect in encouraging bush growth, the control of which is one of the major problems of pasture management in East Africa, but this may have been due to the small size ($\frac{1}{2}$ acre) of the plots used. The natural grasslands of Africa are in the main fire-maintained. Therefore, if we do eliminate fire without substituting some other measure of control, they would gradually disappear and be replaced more frequently not by magnificent forest but by scrubby, impenetrable thicket, which I, for one, would view with much regret!

The Ngong experiment, moreover, does not deal, I think, sufficiently with the relative effects of fierce firing as compared with light burning or "singeing". In the more recent work in South Africa, "singeing" has been giving most promising results as it seems to give the desired effects of burning without unduly encouraging run-off and erosion in areas where these are serious problems.

Finally, I would like to see experiments, such as the one under review, extended to cover all these points of practical importance, as well as the widely varying conditions in East Africa, and to see the changes brought about gauged in terms of animal feed, the production of which is, after all, the primary purpose of pasture management. Meanwhile we can only conclude that the case against grass burning of pasture land in East Africa is "not proven" and, as the author says, "the aim should be to use fire as a controlled instrument of grassland management" where this seems to be required.

R.R.S.

Even the calm, serious spirit of science with its tireless quest for truth, while it can give men the knowledge they require to build a new world, cannot supply either the wisdom or the driving force to ensure that that knowledge is used aright.

Nature.

If we desire to keep alive and vigorous the ultimate springs of our material welfare, and—not less important—to maintain and extend the place of science in our culture, we must jealously guard its freedom and its independence.

Prof. A. G. Tansley in *Nature.*

THE CUTTING OF SEED POTATOES*

By H. C. Arnold, Manager, Agricultural Experiment Station, Salisbury

Many contrary opinions have been expressed on this subject. The reason for so many diverse opinions is no doubt due to the numerous factors which affect the growth and yields of potato plants. The variety, size, age, condition, method of tuber division, method of storage, time of planting, the moisture and temperature of the soil are factors which interplay and affect the final results.

It is well known that under certain circumstances even potato peelings may be used and that when it is desired to propagate a variety as quickly as possible every tuber may be cut into as many pieces as the "eyes" it contains. The pieces are then grown under the most favourable conditions and a large number of new tubers is obtained from each parent tuber. Only when the soil and moisture conditions are very favourable to plant growth can the cutting of the tubers into such small pieces be practised with success.

When tubers are planted in hot, dust-dry soil and remain there for several days or even weeks before the rains arrive, the growing shoots depend on the reserve materials in the tuber, and if those reserves are much depleted before rain falls, the subsequent development of the potato plants will be retarded and curtailed. To allow for a margin of safety, the pieces should weigh three to four ounces or even more, and they should have one or two short, sturdy sprouts.

Experiments have shown that the main buds at the apex of the tuber have an inhibiting effect on those at the base, or "heel" end, and when the tubers are cut transversely after sprouts have formed, the crop obtained from the "crown" ends may be considerably larger than that from the heel ends.

In experiments conducted at the Salisbury Experiment Station, when tubers which had commenced to sprout some four months previously were cut transversely immediately before planting in dry soil, the crown or apical halves yielded 50 per cent more than the heel ends. A number of the heel ends did not survive, so there were several "misses" in the stand, which adversely affected the yield. The yield from whole tubers was considerably higher than that of the crown ends of the cut tubers. It is seen, therefore, that when cutting is delayed until after sprouting has commenced it is advisable to cut the tubers longitudinally.

The results of this trial indicate that when it is proposed to cut tubers into more than two pieces before planting in dry soil it would be advisable to do so before they commence to sprout, and thus counteract the inhibiting effect which sprouted apical eyes normally exert over those at the heel ends of the tuber.

Another point which deserves attention is the treatment of the tuber pieces immediately after cutting. The cut surface exposes a large area to loss of moisture and fungoid attack. The potato tries to remedy this by exuding a kind of varnish known as suberin. Subsequently a thin layer of cork cells, similar to those which make up most of the skin, are formed below the suberin and the cut surface is thus protected from disease attack and loss of moisture is reduced.

The deposit of suberin is both encouraged and hastened by keeping the cut tubers in a moist atmosphere away from the light for a day or two. Exposure to sunlight and dry air prevents, or at least reduces, the formation of suberin, and a patchy, defective covering of cork cells results.

Cutting should be done in a sheltered place and the pieces should be covered with damp sacks or other protective material for a day or two (though not longer) to encourage the formation of an even and complete layer over the cut surface. They should then be stored in a cool, light, airy place, where short, sturdy sprouts will develop. Diseased and shrivelled pieces can be discarded at planting time.

In tests conducted at the Craibstone Experiment Farm, Scotland, it was found that a coating of lime over the cut surface immediately after cutting prevented the surface from drying so quickly and the healing process was assisted; there were fewer blanks in the crop than was the case when cutting was done in the sun and the sets were kept in a bright place.

Investigators have found that certain varieties will not "suffer" cutting. With one such variety at least satisfactory results were obtained when about a quarter of an inch at the heel end was left uncut and the tubers were stored. The two halves remained attached until planting time, when the condition of the sprouts indicated whether they could safely be planted.

* Adapted from *Rhodesian Agricultural Journal*, Vol. 38, pp. 599–603, 1941.